Spotlight
ON COTTON R&D

SUMMER 2022-23

WAND goes live in QLD

Circularity gains new ground

Celebrating 30 years of ARLP

CRDC

Dr Ian Taylor

In the Spotlight

In this edition of *Spotlight* we outline some of our landmark research and development (R&D) investments that are addressing major challenges in the cotton industry, including spray drift and textile waste.

I recently made the trip to see one of the spray hazard warning system towers – now known as WAND towers – up and running east of Goondiwindi (Bigambul country). The towers represent six years of planning, research and collaboration with the grains industry, chiefly the team at GRDC to help reduce the instance and minimise the impact of drift.

The WAND network, which is being delivered by Goanna Ag, represents the single largest investment in CRDC history. During the R&D phase, GRDC and CRDC-supported researchers developed the first and only reliable and accurate method to determine when hazardous inversions are present. This is a major development and is indicative of what we can achieve when we work together. WAND is now operational in QLD and is being rolled out in NSW: we encourage all growers and spray contractors to connect to WAND today.

We are also ramping up our investment in textile waste projects to ensure we play our part in closing the circularity loop. With Cotton Australia, we have a mandate through our PLANET. PEOPLE. PADDOCK Sustainability Framework to create a more sustainable industry, and at the same time, this research is also potentially creating a feedstock for growers to return to their fields. The involvement of growers is vital to testing the process and we are delighted to see Scott Morgan come on board this season, with Sam Coulton continuing on from last season. Our circularity R&D has a natural fit with research into soil health and the holistic management of soil as the largest living organism on the planet.

It also has a fit with our fellow natural fibre stablemate, the wool industry. With Australian Wool Innovation and the Woolmark Company, CRDC was a supporter of the Threads and Opportunities Symposium, which brought together people from every aspect of the Australian textile landscape. The purpose of the event was to connect those with interest and expertise in developing sustainable, innovative pathways to achieve circularity and reduce textile waste. We know that solutions can be found when we get everyone in the room and we're already seeing brands looking closely at the recommendations and big ideas coming out of this forum.

In this edition, we've also included a nod to 30 years of the Australian Rural Leadership Foundation's Australian Rural Leadership Program (ARLP), with 44 cotton industry-supported people participating over this time. CRDC and others' investment has certainly had a huge impact on our industry, with so many of the alumni going on to hold leadership positions.

I'd also like to congratulate Cotton Australia on its 50-year milestone. The industry has come a long way since the first iterations of the organisation and the role Cotton Australia has played cannot be understated. CRDC looks forward to continuing our work with Cotton Australia on projects such as PLANET. PEOPLE. PADDOCK. and circularity.

As we head into cotton 2022-23, we are thinking of all those facing testing weather conditions. We encourage you to contact your local CottonInfo Regional Extension Officer for any information or advice you may need to deal with what is already an extremely challenging season.

Dr Ian Taylor
CRDC Executive Director

CRDC acknowledges Australia's Indigenous people as the traditional custodians of our country, and recognises their continuing connection to lands, waters and culture. We pay our respect to Elders past, present and emerging, and extend that respect to all Indigenous people.

Summer 2022-23

Spotlight is brought to you by Australia's cotton growers and the Australian Government through the publisher Cotton Research & Development Corporation (CRDC). CRDC is a research and development partnership between the Australian cotton industry and the Australian Government.

CRDC
COTTON RESEARCH AND DEVELOPMENT CORPORATION

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Our mission: To invest in RD&E for the world-leading Australian cotton industry.

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ON THE COVER:
CRDC Executive Director Dr Ian Taylor, GRDC Manager Chemical Regulation Gordon Cumming, Goanna Ag CEO Alicia Garden and GRDC Chair John Woods at one of the new WAND towers at Goondiwindi (Bigambul country).

Want to see more of Spotlight?

This edition can be viewed online at: www.crdc.com.au

COTTON NEWS

FEATURES

Recognising man's best friend

THE saying goes that 'every dog must have his day' but the CottonInfo team decided that our four-legged farm mates deserve a whole 12 months!

The Dogs of Cotton 2023 CottonInfo Calendar features furry friends from Goondiwindi (Bigambul country) to Gunnedah (Kamilaroi country) and beyond, all submitted by proud owners. It's hoped that the calendar offers up a daily reminder of the support and companionship a dog offers unconditionally, season after season.

"The CottonInfo team ran a photo competition, kindly supported by Goondiwindi Cotton, with Sam Coulton acting as our guest judge," said CottonInfo Regional Extension Officer Andrew McKay.

"Sam selected the winning pic by Annabel Rogan at St George (Kooma country) which takes pride of place on the front cover of the calendar. Annabel will receive a $150 Goondiwindi Cotton gift voucher – and hopefully her pooch Jill also gets a treat!

"Thanks to everyone who sent us pics of theirs or someone else's beloved hounds."

For more
www.cottoninfo.com.au/cottoninfo-cotton-calendar

Bringing experience and understanding to cotton

COTTONINFO'S new communications lead Megan Woodward is bringing a passion for agriculture, research, development and extension (RD&E) to the cotton industry.

Megan joins the 21-strong CottonInfo team, which includes on-the-ground Regional Extension Officers across the cotton growing valleys, Technical Leads and *my*BMP support staff.

Originally a North Queenslander from Mackay (Yuwi country), and with a family history of cattle graziers, coal miners, and 'growing up amongst the cane', an interest and understanding of rural issues and agriculture was something that's always inherently been a part of Megan's life.

Megan is an experienced communications professional, with a wealth of experience and insight, having worked for ABC *Landline* and delivered communications projects for several of CRDC's fellow research and development corporations, including AgriFutures Australia, Meat & Livestock Australia and the Grains Research and Development Corporation.

"My time as a tv reporter for the ABC saw me cover a patch from north of Rockhampton (Darumbal country) to the Cape and west to the Queensland/NT border," Megan said.

"For nearly a decade I got to travel and talk to people for a living – I contributed to the evening news, *Stateline*, *Landline* and *ABC24* in its early days.

"My cameraman and I often said we were the Bureau for dirt roads, droughts and drenchings!

"Moving into ag and science communications is a logical professional step. Within CottonInfo, my job will be ensuring our growers get the best information in the best way possible to ensure the continued productivity, profitability and sustainability of their operation."

Megan moved to South-East Queensland 10 years ago, and most recently she's has been working with one of CRDC's research partners, the University of Southern Queensland

Megan Woodward is joining the cotton industry communications team as CottonInfo's Communications Lead.

delivering RD&E communications.

"I've been afforded some great insights into the cotton industry over the past 20 years and have found the people involved – from growers to agronomists to researchers and everyone in between and either side – to be consistently committed to the betterment of the sector," Megan said.

"In previous roles, I've have had the privilege to see first-hand the impact of good R&D on farm and report on those outcomes.

"On the other side of that, I've been lucky enough to work in ag-science communications and deliver those key messages to help support engagement and adoption.

"I'm looking forward to getting out and meeting more people throughout the industry and continuing the good work of CottonInfo and its partners."

As the CottonInfo communications lead, Megan will work directly with CottonInfo Program Manager Warwick Waters, and the CottonInfo partner organisations CRDC, Cotton Australia, and CSD.

For more
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www.cottoninfo.com.au

Nuffield scholar investigates sustainable farming development

COTTON'S 2023 Nuffield Scholar is Tim Houston, a dryland cotton grower from between Mungindi (Kamilaroi country) in Northern NSW and Inglestone (Barunggam country) in Southern Queensland.

Tim runs Sandholes Farming alongside parents Rob and Sally, an operation of around 11,000 ha. In addition to dryland cotton, they grow wheat, barley, chickpeas and sorghum, Australian white sheep and a brangus breeder herd.

Through Tim's Nuffield scholarship, supported by CRDC and Cotton Australia, he will investigate how governments and landholders can work together on sustainable farming development. Tim will visit several countries including Kenya to conduct his studies, using his scholarship to explore how farmers in other parts of the world are navigating the challenge of changing land use regulations and expectations.

CRDC's Executive Director Dr Ian Taylor says Tim's study focus is timely, given global developments around biodiversity: a current focus of CRDC, Cotton Australia and the cotton industry.

"At the industry level, we are working to be at the forefront of these global developments in an attempt to make them relevant to the Australian cotton industry, rather than wait for northern hemisphere policies to be imposed on us," he said.

"It will be very interesting to hear about Tim's experiences and findings from farmers, organisations and governments in other countries through his study, and look forward to sharing them with the broader industry."

2023 Scholar Tim Houston (centre) receiving the cotton scholarship with Chair Robert Bradley and cotton grower and 2006 scholar Andrew Watson from Boggabri.

For more
www.nuffield.com.au

Information at hand for testing times

IT'S been a testing couple of seasons for many cotton growers.

Flooding continues at Mungindi (Kamilaroi Country) and the Border Rivers region, yet growers are finding a way to make season 2022-33 happen.

Mungindi grower Sam Heagney's Twitter post paints a very clear picture of the lengths some are going to in battling floods to get to fields which may be just dry enough to plant. Sam's farm was cut off by the flooding, with seed on one side and the tractor on the other.

In the Namoi Valley (Kamilaroi Country) and Central West (Wiradjuri country), some growers are still dealing with last season's crop. With the effects of the current triple La Nina still being felt and predicted to carry through until early next year, crop management won't be without its challenges. Weed, nutrition and disease management will be paramount, and for some regions, particularly the south, short growing seasons do not lend themselves to a delayed planting.

The extremely wet weather over October and November is likely to have an impact the availability of key nutrients and managing for this will be critical for yield potential this season.

CottonInfo Border Rivers, St George and Dirranbandi Regional Extension Officer Andrew McKay said given the disrupted ground preparation and excessive wet/flooding, nutrition management will be a primary consideration.

To address this, CottonInfo held a webinar in November to discuss managing early crop nitrogen (N) needs, which is available for viewing via the CottonInfo website. The webinar includes some brief perspectives of soil processes in wet soil, case studies highlighting changes in soil N quality and profile location, and some suggested alternative seasonal N management approaches.

Stay tuned to CottonInfo during the season for more information and advice on managing crops in wet seasons or talk to your local regional extension officer for links to information from industry research, publications and manuals.

For more
www.cottoninfo.com.au

Goanna Ag CEO Alicia Garden giving GRDC Chair John Woods and CRDC Executive Director Dr Ian Taylor a run-down on the new WAND app, at 'Nymboida' Goondiwindi (Bigambul country), where a WAND tower has been installed and is ready to use.

Spray hazard warning network goes live in Queensland

A major milestone has been reached in the effort to help minimise spray drift, with a hazardous weather warning system now live for Queensland grain and cotton growers.

The system – named Weather and Networked Data or WAND – is the result of six years of collaborative research by the Grains Research and Development Corporation (GRDC) and CRDC into meteorological conditions and the spray application of crop protection products.

Earlier this year GRDC and CRDC partnered with Goanna Ag to deliver this new technology to growers and spray applicators. The technology will provide real time weather data about the presence and absence of hazardous temperature inversions.

Goanna Ag has now completed construction of the first 33 WAND towers across the grain and cotton regions of Queensland. A further 10 are also fully operational in NSW, and as flood waters subside, another 57 towers will be erected, bringing the total tower network to 100.

"A significant amount of the Queensland cotton cropping belt is today within 40km of a WAND tower, providing critical information for spray hazard identification to the grain and cotton regions of central and southern Queensland," said Goanna Ag CEO Alicia Garden.

"WAND will deliver growers and their spray contractors up-to-date weather data updated every 10 minutes, identifying hazardous temperature inversion periods, giving them confidence to proceed with spray operations."

GRDC Chair John Woods said having the WAND system live in Queensland would provide enormous benefits to grain and cotton growers this summer.

"This is an important and progressive step for agriculture and GRDC are really pleased to have partnered with CRDC to support researchers Dr Graeme Tepper and Dr Warwick Grace to develop the first – and only – reliable and accurate method to determine when hazardous inversions are present," John said.

"We have now brought the technology and analysis to the market, into growers' hands, through our enabling partner Goanna Ag."

CRDC's Executive Director Dr Ian Taylor said the network going live was the culmination of six years of collaborative research and development and urged cotton and grain growers to begin using WAND.

"This type of research and innovation is exactly why GRDC and CRDC exists – to make a real, tangible difference to our growers and their communities," Ian said.

"WAND is available to all growers and contractors free-of-charge and we encourage them to sign up today.

"Queensland growers can start using the system immediately, as can some growers in NSW, with the full NSW system expected to be live by March."

For more
WAND
www.wand.com.au

Cotton Australia raises the bat on half century

2022 marks a 50 year milestone for cotton's industry body.

Cotton Australia is a unique organisation with its roots based firmly in the early years of Australia's cotton industry.

Established to support Australia's cotton growers and represent their interests, the organisation has played a significant role in positioning the industry as it is today: both forward-thinking and environmentally responsible.

Cotton Australia stems from two organisations: the Australian Cotton Growers Research Association (ACGRA) and the Australian Cotton Foundation (ACF). In 1997 the ACF changed its name to Cotton Australia, and in 2008 merged with ACGRA. These two organisations supported the mutual outcomes of a viable and sustainable cotton industry in Australia, underpinned by world-class research and development.

ACF was established in 1972 by Namoi Cotton Cooperative, Auscott Limited and the Queensland Cotton Marketing Board. These organisations financed ACF, along with a $0.23 per bale grower levy. ACF began as a client of communications firm Professional Public Relations that provided issues management advice and promoted the cotton industry.

Also in 1972, ACGRA was formed with Richard Williams as Chairman to raise and invest grower dollars in research projects, funded by a voluntary levy of $0.25 per bale. Members were Namoi Cotton Cooperative, Auscott Limited and the Queensland Cotton Marketing Board, Cotton Seed Distributors and the Ord River Cooperative.

Cotton Australia has provided a united voice for cotton growers across research and development, stewardship, natural resource management and cotton production issues. The organisation has been consistently successful in interacting

with governments at state and federal levels, educating the community about the positive contributions of the industry and encouraging growers to adopt myBMP – the industry's best practice program.

Cotton Australia CEO Adam Kay said the ACGRA was the cotton industry's original research and development driver. It guided the spending of the CRDC's compulsory levy collected from growers and guided the CRDC on where this should be invested as it still does today, with the aim of ensuring a program of proactive and pre-emptive grower-focused research, development and extension activities.

"ACGRA as Cotton Australia does today, facilitated a link between growers, researchers, research funding bodies, government and industry groups," he said.

"This led to a strong profile as an organisation that championed effective grower-focused research.

"Over time, ACGRA and Cotton Australia acknowledged the benefits in developing a single, solid platform for the next generation of the industry.

"Merging the two organisations had the practical advantages of better linking R&D to policy development, avoiding duplication, and taking advantage of the many synergies between the two bodies."

In 1990, the Australian Government formed CRDC and its fellow research and development corporations, with a compulsory grower levy for research, development and extension (RD&E) matched by the Government. ACGRA took on the role as the industry representative body, while CRDC took up the mantle of investing in research, development and extension (RD&E) for the industry.

Today, with a board made up largely of cotton growers, Cotton Australia continues to work closely with CRDC to ensure RD&E is relevant and useable to cotton growers.

CRDC Executive Director Dr Ian Taylor congratulated Cotton Australia on achieving the 50 year milestone and paid tribute to all those who have served in the organisation and on its boards, and in those of its founding organisations, ACF and ACGRA.

"The Australian cotton industry is home to incredibly capable, resilient and knowledgeable people, who are represented through Cotton Australia," he said.

"It was the foresight of early founders to create organisations that would manage RD&E and promote and represent the industry.

"There have been points throughout our history where, were it not for these organisations, the industry would not be where it is today – a world leader in sustainability, best management, and RD&E.

"CRDC extends its appreciation to all those who have been a part of Cotton Australia for the continued time and effort they have given the industry, which has led to us being global leaders across basically every aspect of cotton – from field to fabric."

For more
www.cottonaustralia.com.au

Direct focus on grower needs and participation in new research initiative

Cotton Seed Distributors (CSD) and CRDC are partnering to support the delivery of research to benefit growers.

CRDC General Manager R&D Investment Allan Williams, CRDC Executive Director Dr Ian Taylor and CSD's Peter Graham have worked together to extend the capacity of the Richard Williams Initiative.

Two substantial investments in disease and water management will be funded by CSD's Richard Williams Commercial Research Initiative and CRDC, and delivered through research partners Crown Analytical Services and Goanna Ag.

These research initiatives were developed in response to feedback from growers through the cotton industry's extension network, including the CSD team and CottonInfo: a partnership of CRDC, CSD and Cotton Australia.

Disease is a prevalent issue, and this investment will support research led by growers on the ground, investigating the effect of farming practices on disease levels and crop returns. The research will involve growers and agronomists actively collaborating in each stage of the research, through the establishment of eight 'disease action groups' facilitated by the CottonInfo Regional Extension Officers. Each action group will investigate management practices that aim to reduce disease incidence and improve cotton productivity.

The second investment focuses on supporting growers to manage their on-farm water accounts by gathering information from various data sources. Growers can monitor their water availability and where it is located in real-time through a dashboard. Access to this information will help growers make better management decisions to increase their productivity and profitability.

For Peter Graham, Managing Director of CSD and Dr Ian Taylor, Executive Director of CRDC, joint investment in research is the next step in a long-standing partnership between the two industry bodies.

"CRDC and CSD have a long history of collaboration, having been joint partners in CottonInfo with fellow partner Cotton Australia since 2012, delivering vital extension services to the cotton industry," Ian said.

"Now we have extended that collaboration to co-investment in research, helping deliver additional benefits and tangible impacts to growers.

"The two research initiatives announced today are the result of feedback from growers through our CottonInfo network and align with the research priorities communicated to us through Cotton Australia's research advisory panels."

These initiatives are anticipated to be the first in an ongoing series of joint investments between CSD and CRDC. The teams continue to work closely to identify future opportunities for collaboration.

"Investing in this type of research is new to CSD," Peter said.

"While CSD has invested significantly in bringing the best varieties to the industry through Cotton Breeding Australia, the Richard Williams Initiative is focused on complementing and expanding on existing industry research efforts by having a strong grower focus.

"Ideas for future investment initiatives can be shared with your local CSD extension agronomist or CottonInfo team member."

The CSD's Richard Williams Commercial Research Initiative honours the late Richard Williams for his outstanding contributions to the cotton industry and the creation of CSD. Richard was a pioneer of the modern Australian cotton industry, supporting the formation of Cotton Seed Distributors in 1967, becoming a Director of CSD. In 1968, he became CSD's Chair, a position he held for 21 years. Today, his legacy in the cotton industry is continued through his son, Allan Williams, CRDC's General Manager for R&D Investment. (see story next page.)

For more

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Richard Williams: a life dedicated to cotton

One of the industry's most respected members, the late Richard Williams, has been memorialised through a research initiative developed by Cotton Seed Distributors (CSD).

Richard played a pivotal role in the formation of the Australian cotton industry through his vision to have cotton growers invest in and oversee research and development (R&D).

As a major supporter of the formation of CSD in 1967, Richard was one of the first directors and became chair the following year, a role he held for 21 years. He had a passion for seeing growers invest in, and initially manage, R&D to address the early challenges of the industry through the establishment of the Australian Cotton Growers Research Association (ACGRA) in 1972. He was the inaugural chair of ACGRA and the Australian Cotton Conference. CSD became a foundation sponsor of the event and remains so today.

During his term at CSD, Richard formed and grew CSD's relationship with CSIRO, and was a major force in advocating for the organisation to move its cotton research work, then based at Yanco NSW (Wiradjuri country) and the Ord WA (Miriwoong country), to Narrabri NSW (Kamilaroi Country). This move underpinned the establishment of the National Cotton Research Centre, now the Australian Cotton Research Institute at Myall Vale, west of Narrabri. One of the CSIRO personnel who moved from the Ord was plant breeder Dr Norm Thomson, largely considered one of the fathers of Australian cotton breeding.

Richard's time as chair of CSD saw the release of Sicot varieties (1983) and Siokra (1985), both bred by Dr Thomson and his team. Siokra was the first bacterial-blight-resistant variety in Australia and became the first widely-grown Australian-bred variety. Richard's belief in the strength of partnerships saw CSD become the exclusive agent for the domestic marketing of CSIRO cotton varieties, and today, CSD and CSIRO continue to work together as Plant Breeding Australia.

CSD sought to find a way to honour and memorialise the industry great, and therefore started the Richard Williams Commercial Research Initiative, which has now partnered with CRDC on two research projects.

CRDC's involvement in the Initiative is particularly poignant for Richard's son Allan, who like his father has been an active advocate for the cotton industry during his career and is currently CRDC's General Manager of R&D Investment. Both father and son share an interest in ensuring a sustainable and prosperous future for cotton in Australia.

"Dad dedicated his life to ensuring that the industry had access to high-quality R&D that was strongly guided by the needs of growers and the broader industry," Allan said.

Richard Williams was a quiet achiever who worked hard to create a culture of grower involvement in R&D.

"He was always keen to test the latest technology, and I have abiding memories of SIRATAC, with its modem that you plugged your telephone handset into!

"It has been very touching for our family to have him remembered in this way, as a quiet achiever of the industry.

"He felt that giving growers tools, expertise and access to R&D was vital to the industry."

CSD Commercial Research Manager Dr Mike Bange said in line with Richard's ethos, grower needs are at the forefront of the Richard Williams Initiative.

"Richard's legacy and input continues to shape the industry today, and in line with his thinking, this initiative will be principally guided by cotton growers and their agronomists," Mike said.

"We want to ensure we have meaningful engagement with growers so we can understand their local issues and needs. This is all about serving them, what they want and what they need.

"A key to this initiative is working closely with others in the industry investing in research, like CRDC, as we want to add to what is being achieved already."

An important step in identifying a scalable long-term solution to the issue of textile waste in landfill is now underway with cotton farmers launching phase two trials in NSW as well as at Goondiwindi (Bigambul country) in Queensland.

Trials returning textile waste to cotton fields expanded

Inspired by the environmental benefits of diverting 800,000 tonnes of textile from landfill each year, Goondiwindi Cotton's Sam Coulton, who hosted the phase one trial, is being joined by Scott Morgan at Gunnedah (Kamilaroi country).

Scott is already a leading cotton grower in terms of sustainability and said his decision to take part was an easy one. He's been proactive in investigating and installing renewable energy options as an early adopter of a large-scale solar generation and has undertaken numerous water conservation projects.

"I'm excited about returning 100 percent cotton back to farms because I think it's the right thing to do for the environment by helping close the circularity gap," Scott said.

"My strong hope is that the cotton waste can improve soil health and microbial activity – thereby improving crop yields."

The growers will be spreading the shredded material once their cotton has emerged, rather than pre planting due constraints caused by the recent continued wet weather.

"Phase one trials were positive, but with COVID and poor weather we were limited in what we could achieve," Sam said.

"I am hopeful this next phase will provide some vital answers to questions and lead to a regular process that will be seen as the start of a major transformation in cotton circularity."

CRDC-supported soil scientist Dr Oliver Knox oversaw phase one, finding that cotton textile waste had no adverse impact to soil health or cotton yields and that in healthy soils a huge volume of shredded cotton could be broken down completely by soil microbes.

"This work is very important in helping to resolve the issues caused by Australians throwing away around 25 kilos of textile waste per person each year," Oliver said.

"We hope the next phase will prove this concept across a wider landscape, and it will also see us divert 10 times the amount of textile waste from landfill compared to the initial phase."

COTTON AUSTRALIA

Goondiwindi cotton grower Sam Coulton has been integral in trial work to test the recycling of cotton fabric waste into his fields.

For the 2022-23 trial, program partners Cotton Australia, Goondiwindi Cotton, CRDC and Sheridan have been joined by Thread Together.

While Thread Together's primary purpose is to partner with the fashion industry to divert brand new clothing apparel, footwear and accessories from landfill and provide these to people in need, in some circumstances, the amount of new clothing for some product lines far exceeds current demand.

Founder Andie Halas said rather than cotton waste, they are dealing with excess stock.

"Thread Together never declines a donation of excess clothing and sometimes this creates more supply than demand," Andie said.

"As part of this new challenge, we are pleased to be working with Worn Up to ensure 100 percent cotton garments are shredded and sent to cotton fields in Gunnedah."

President of Hanes Australasia Tanya Deans said after the success of the phase one Goondiwindi trial, Sheridan is pleased to be involved in a larger trial across two farms.

"Progress towards circularity is an important part of our sustainability journey and Hanes is committed to supporting an additional site in Gunnedah and will be providing 10 tonnes of cotton waste offcuts for the project."

Leading the project is Cotton Australia's Brooke Summers who works closely with brands through the Cotton to Market program.

"The results from phase one show it's possible to find a scalable solution to cotton textile waste right here in Australia," Brooke said.

"Our farmers want this and cotton consumers want it too. They are demanding environmental solutions as part of their purchasing decisions.

"Phase two should bring us a step closer, but we need the committed involvement of governments, industry groups, brands and potential investors."

Oliver will assess the progress of phase two across both locations.

Increasing support for circularity

In addition to supporting Dr Oliver Knox's research as part of the Goondiwindi and Gunnedah circularity trial, CRDC has allocated almost $2m over the next three years to a suite of projects aimed at increasing the understanding of the science of textile waste breakdown and its effects on soil health.

The research will also look at the logistics and business challenges of processing and transporting textile waste back to cotton farms, with the findings used inform the circularity trial and future research, as well as identify ways the cotton industry can be a part of the emerging circular economy for textile waste.

CRDC R&D Manager Dr Meredith (Merry) Conaty said the research would be a game-changer for cotton if it solves the ever-growing issue of textile waste.

"Each Australian consumes almost 25kg of new clothing each and every year, but to date, there is no scalable solution for composting textile waste, which is the ultimate end of life solution after other reuse and recycling options are exhausted," says Merry.

"In working towards a solution, we need scientific rigour to fully appreciate the soil science and the long-term impact of returning textiles to the farm – we need to consider the impact on carbon footprint, soil health and waterways, and the benefits to farmers, brands and customers," she said.

One of the projects already underway under this program of work is a three-year investment with the University of Newcastle to further investigate the effects of dyes and finishes from waste material on soil health. The work is specifically researching the diversity, growth and functioning of soil microbes which are critical for the health and resilience of soils across the landscape.

This project will also look at ways to pelletise cotton textiles through biological breakdown of the waste material, to enable spreading on fields using existing farm machinery. Presently the material is added to fields in shredded form.

"We need to ensure that our solutions are practical for growers," Merry says.

"So our research needs to include these as fundamental aspects if we want to see broad uptake of innovation.

"Importantly, we have growers like Sam Coulton and Scott Morgan involved from the very start, plus we're co-designing this area of research investment with Cotton Australia's Cotton to Market program, to ensure the needs of brands and retailers are considered."

CRDC and Cotton Australia have also recently developed a framework for improving sustainable soil use in the cotton industry via the industry's PLANET. PEOPLE. PADDOCK Sustainability Framework.

COTTON AUSTRALIA

The textile waste was added at different rates across the trials. Future research will look at pelletising the cotton strips for ease of application with existing machinery.

The proposed framework seeks to promote soil health by bringing attention to how much 'life' is in it – a concept so cleverly illustrated through the Soil Your Undies initiative, led by CottonInfo Soil Health Technical Lead Oliver Knox.

The new soil health framework shows how soil principles, practices, properties and functions are all linked. It also shows that dictating certain practices or asking farmers to focus on improving a specific property or function of soil is not the way to proceed. As the National Soil Strategy notes: "... soil management practices must be flexible and tailored to support productivity and reduce soil degradation in different landscapes".

As well as talking to growers, CRDC and Cotton Australia are also using this framework to help shape the soil health conversation with scientists and other industries, as they work towards developing a consistent understanding of soil health and how to measure it. For growers, the *my*BMP soil health module is being updated by Oliver (who is also the soil health module lead for *my*BMP) to reflect the framework, and CRDC will be using it to guide research investment decisions.

For more

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Soil health framework

www.crdc.com.au/growers/sustainability#soilhealth

Top Landcare award to cotton soils researcher

A fun initiative focused on soil health played an important part in the industry's broader commitment to sustainability by addressing cotton textile waste.

The awarding of the Landcare General Jeffrey Soil Health Award to soil scientist Dr Oliver Knox in August this year recognised his work in championing, improving and educating others in soil health, with particular mention of the Soil Your Undies campaign. For the cotton industry, Oliver's work and passion for soil health has, in part, led to larger work to support the vision of a circular economy for Australian cotton by returning cotton textile waste to cotton fields.

Oliver is an Associate Professor in Soil Systems Biology in the School of Rural and Environmental Sciences at the University of New England (UNE), a leading soil health champion, educator and researcher. He is also the CottonInfo Technical Lead for Soil Health. The Award was granted to Oliver in recognition of his outstanding efforts to embed learning and understanding of soil health from the field to the classroom.

"It was an honour to be considered for the General Jeffrey award for doing my little bit to help promote soil health, although my work would not be possible without the growers, school classes and community groups who are prepared to take a moment to share the magic of their soils with me. This recognition is for them as well," Oliver said.

"We've come a long way since grower Nigel Corish first heard of Soil Your Undies in the UK through his Nuffield Scholarship, and CRDC and the CottonInfo Regional Extension Officers got those first growers to soil their undies.

" Australia's ability to produce, use and eventually recycle out natural fibres has to be part of this journey."

"It grew further with the support of a small group of growers and their willingness to share their underpants with others at the 2018 Cotton Conference, creating a lot of interest right across the industry.

"Continued CRDC and cotton industry support has allowed me, with the help of others, to take this to an even wider audience and now influence others around the world: that's pretty phenomenal."

The award will be used to revamp the Soil Your Undies website, allowing participants to see how their pants compare to others across the country or their state.

There have been other significant spin offs from the campaign. In early 2019, Oliver soiled the first cotton and poly-cotton pair of pants.

"The very visible comparison of the undigested polyester webbing, the discussion of its potential fate in our environment and how much of our clothing is no longer made from natural fibres led to my involvement in work attempting to address some of our current waste challenges," Oliver said.

This work informed phase one of the Circular Cotton Project, spreading shredded cotton textiles onto Sam Coulton's cotton field at Goondiwindi (Bigambul country) in 2021. Prior to this, Oliver assessed the biodegradation process for potential benefits such as carbon and water retention in soils. He saw increased levels of microbial (bacterial and fungal) activity in all but one cotton sample and all but one broke down significantly in about 24 weeks. Initial projections showed 2250kg of carbon dioxide equivalents (CO_2 e) would be prevented from entering the atmosphere through the breakdown of the textiles in soil rather than landfill.

Oliver's field trials are continuing as part of phase two of the Circular Cotton Project, which begins this season (see story page 5). Through these trials, he will assess the breakdown process at different application rates, soil nutrition, respiration/CO_2 and microbial biomass. It is hoped that the results provide evidence for a large-scale circular solution for 100 percent cotton textile products in Australia, which are naturally biodegradable, renewable and recyclable.

Dr Oliver Knox at the National Landcare Awards, where he took home the General Jeffrey Soil Health Award. Oliver is pictured with The Honourable Penelope Wensley AC.

"The trials show we can divert some of our textile waste from landfill to agricultural soils and offset greenhouse gas emissions," Oliver said.

"With the expansion of this work with grower Scott Morgan at Gunnedah, it's all very exciting.

"At a governmental level, landmark commitments have been recently made, one of which is 'to work with the private sector to design out waste and pollution, keep materials in use and foster markets to achieve a circular economy by 2030'.

"Australia's ability to produce, use and eventually recycle out natural fibres has to be part of this journey and as such it is a very exciting time to be part of the cotton industry."

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How bedraggled underpants lead to a soil health movement

In the UK for a Nuffield conference in 2017, Nigel Corish went along to a cereals field day where he saw what looked like the remains of some very bedraggled underpants hanging from a clothesline, immediately grabbing his attention.

"I saw the undies and I thought 'what is going on here?!'," Nigel said.

"When I found out it was an initiative called Soil Your Undies, I thought it was such a great visualisation of soil health.

"During a talk about the initiative, it was mentioned they were using 100 percent cotton undies, as they are able to be broken down in the soil.

"Of course I immediately thought of how this could be connected to cotton growing and how good it would be to put cotton undies back into cotton fields here in Australia."

On his return to Australia, Nigel contacted CRDC to let them know about the Soil Your Undies idea. From there, CottonInfo took charge: getting growers on board, getting Oliver involved, and the rest, as they say, is history.

Since 2018, Oliver has driven the Soil Your Undies soil health program in Australia through his role as the CottonInfo Soil Health Technical Lead. He initially used it as an educational tool with farmers, but with COVID restrictions stopping infield play, the program was adapted to a postal and online citizen science challenge. In the last two years it has been undertaken in around 500 classrooms, educating an estimated 12,000 school children in soil health. The associated radio, TV and print coverage of the program is thought to have brought the concept of soil health to an audience of millions.

"It just goes to show small ideas can lead to something bigger that has real impact," Nigel said.

"The success of the initiative shows we should talk about our ideas: share them with CRDC, on social media, with fellow farmers and researchers.

"Your next idea could create an entire movement."

Soil health is one of Nigel's key areas of interest and he has implemented a range of strategies on his farms at Goondiwindi and Condamine to improve it. His cotton-industry supported Nuffield Australia Farming Scholarship in 2014 was based on nitrogen use in irrigated cotton, which led him to even greater investigation of soils and the need for holistic management strategies and understanding of the complex nature of soil.

"It's been an excellent journey to be on," Nigel says.

"The travel overseas for Nuffield gave me a more rounded view of soil health, and that in order to improve fertiliser use, a holistic approach to soil health was needed that incorporated a range of tactics."

These include considered choice of crop rotations, cover cropping, alternative fertiliser sources and addressing compaction through soil aeration.

"The system is complex and you can't change and improve it overnight," Nigel said.

"I'm always learning and as curious as I was prior to Nuffield, that experience really set me on a path of constant learning and continuous improvement.

"It's so good to see a simple idea like Soil Your Undies grow into a really impactful initiative, educating people within and beyond the cotton industry."

ABOVE:
A field day in the UK was where Goondiwindi grower Nigel Corish first saw Soil Your Undies.

TOP:
Careful choice of rotation crops is an integral part of Nigel's management strategy to create and maintain healthy soils.

For more
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Bringing people together to help close the loop

Closing Australia's natural fibre loop was the focus of a symposium in May that brought together researchers and those interested in developing sustainable, innovative pathways to achieve circularity and reduce textile waste.

ABOVE:
The cotton industry has already been working with fashion brands such as Country Road through the Cotton Landcare Tech Innovations and Cotton to Market projects, with the brand featuring at this year's Australian Cotton Conference 'Australian by Design' parade. The Threads and Opportunities Symposium has created further links with Australian brands.

CRDC partnered with CSIRO to present the *Threads and Opportunities Symposium 2022: science engineering sustainable fibres, for closing the loop in Australia.* Cotton Australia, Australian Wool Innovation and Woolmark also supported the event.

The event was organised by CSIRO with input from researchers at the Queensland University of Technology (QUT), Deakin University, Curtin University, the University of New England, the University of NSW, and the University of Technology Sydney. It was co-chaired by CSIRO's Dr Colleen MacMillan and QUT's Professor Alice Payne. In addition to researchers, participants also included the cotton and wool industries, brands and retailers, governments and students.

It was described as "a unique event, at a unique moment in time" by co-chair Dr Colleen MacMillan, a senior research scientist and cotton fibre team leader with CSIRO.

"Sustainable fibres and textiles are a global priority in terms of resource-flow and energy use," Colleen said.

"In Australia there is a growing interest and shift towards more circular and sustainable systems across several sectors and value chains, including fibres and textiles."

Colleen said the symposium was already having a positive impact on some big names in the clothing industry.

"In early November, APG & Co Group and its stable of fashion brands JAG, Saba and Sportscraft, informed us that the group is using the *Threads and Opportunities 2022 Report* in their strategy on sustainability for their brands," Colleen said.

"APG & Co will also be including our report on their 'Resources / Further Reading' section on the social and environmental websites of each of their brands."

Science and technology are central to this change, with connected people working together to create positive solutions. The symposium was

specifically designed to also create connectivity.

"We realised there is brilliant work happening in Australia surrounding the resources of fibres and textiles, and to help reduce waste through the value chain, but the people behind this were not connected," Colleen said.

"We aimed to create a collective brains trust of scientists and industry professionals, including the next generation of STEM students who are passionate about addressing fibre and textile waste, which is really resonating with today's younger consumer."

Co-chair, QUT's Professor Alice Payne, said that the symposium aimed to create a shared understanding of Australia's key challenges in sustainable fibre and textiles research for circular systems. Alice has been studying sustainability and fashion through a CRDC-supported project with PhD candidate Zoe Mellick, and researchers from the UK.

A diverse array of experts in circular economy and sustainability from Australia and around the world shared current thinking and practice, with a focus on lessons from First Nations Australia and New Zealand, fibre redesign, and fibre and textiles during their lifespan.

"Place-based solutions are key to solving complex ecological and land management issues," said Stephanie Beaupark, a Ngugi artist, curator, chemistry PhD candidate, and Associate Lecturer at the University of Wollongong (Dharawal country).

"I hope one day we can create an Australian Indigenous textile dye industry that is run the cultural way and is Indigenous led."

Several CRDC-supported researchers also presented, including CottonInfo Soil Health Technical Lead Dr Oliver Knox and CSIRO research scientist Dr Xiaoqing Li.

Xiaoqing is 2022 CRDC-supported ABARES Science and Innovation Awardee for her work in cotton traceability: a key element in tracking the sustainability credentials of cotton fibre. With colleagues in CSIRO's Novel Synthetic Plant Fibres team, Xiaoqing developed an engineered cotton germplasm, which produces a protein not found naturally in cotton fibres. Xiaoqing is investigating whether this protein could be used to trace cotton back to its original source.

"If this protein is stable and can be detected after the fibre matures, we can possibly trace it from the beginning to the end of the life of the fibre, leading us in a new direction in developing plant-based tracing technology," Xiaoqing says.

Alice said the symposium led to the identification of key research questions around the themes of visibility, collaboration and responsibility.

"Combining science and tech to enhance the sustainability of our environments whilst promoting future Australian industries is our major aim," said Alice.

"Through the symposium, we have built connections between experts in these fields and identified future research priorities for us to tackle. We've created positive forward momentum on improving circularity and reducing textile waste."

To keep the group connected, Colleen has established a 'threads and opportunities' LinkedIn group, open to all in the fibre value chain to connect, learn, share and collaborate. CSIRO is also now exploring an initiative to help catalyse the transition to a circular economy for Australia with partners and collaborators across multiple sectors, including natural fibres and textiles.

" Science and technology are central to this change, with connected people working together to create positive solutions."

Big ideas and opportunities emerging from the symposium:

- **Biomanufacturing – designing and generating renewable fibres which can be used as a feedstock at end of life, reducing land and water consumption.**
- **Enabling connected yet dispersed local fibre and textile manufacturing and supply chains making products that are better than current unsustainable textiles.**
- **Close collaboration of science with the design industry, ranging from emerging small-to-medium enterprises to big players.**
- **Replicating all of the functionality of fossil oil-based fibres with natural biodegradable fibres.**

For more

www.linkedin.com/groups/14135066/

Symposium report

www.doi.org/10.25919%2Fm85p-vb72

Floating the concept of energy generation from storages

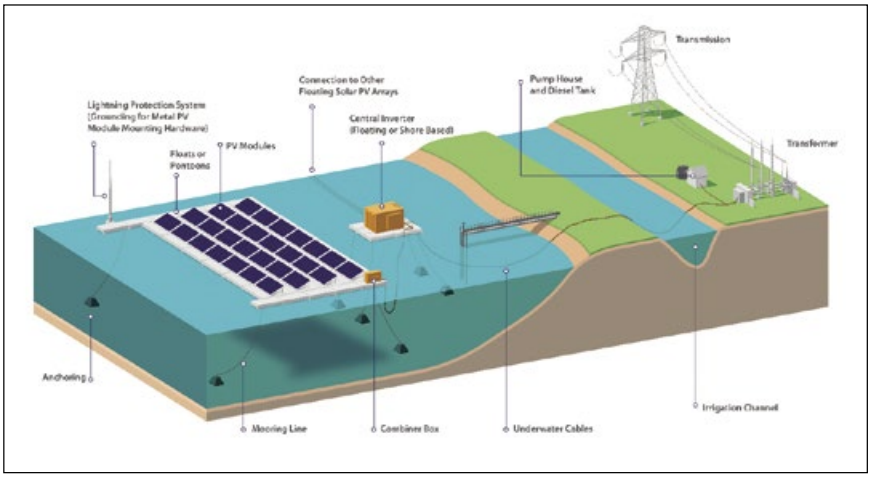
Could floating solar systems prevent evaporation and generate energy?

Floating solar photovoltaic (FPV) systems on water storages have the potential to address the industry's concerns around losses from evaporation and the cost of traditional energy, while at the same time contributing to decarbonisation by reducing emissions and improving sustainability.

Findings from a recent study commissioned by CRDC with economists at Ag Econ, show that beyond evaporation mitigation, FPVs could have an important part to play in reducing growers' energy costs and carbon emissions. They also have the potential to create large-scale energy generation in government-designated Renewable Energy Zones emerging in some cotton growing areas.

Ag Econ's Jon Welsh says previous gross margins studies estimate the marginal value of a megalitre of water at $387, so as little as a 10 per cent savings in evaporation from stored allocation across the industry could create a $41 million benefit if 80 percent of the water retained were used to grow cotton.

"In addition, previous industry research shows energy from water lifted into six-meter-high storages produces carbon emissions from diesel-powered pumps at approximately 212,256 tonnes of CO2e per year, and unlike emissions from fertiliser, has no corresponding plant growth, carbon sequestration or farm productivity benefits," Jon said.



Schematic of floating PV design on the case study cotton farm.

"Applying the current forecast crop size of 5.2 million bales across assumed full irrigation storages, these energy losses equate to a theoretical environmental cost of around 40kg CO2e per cotton bale.

"Our study also showed emissions improvements of 59kg CO2e per cotton bale under one of the FPV scenarios.

"Reducing evaporation storage losses and creating energy on farms would therefore have tangible positive economic and environmental flow-on effects."

Currently the cotton industry is heavily reliant on diesel fuel to power irrigation pumps, with many remote growing locations having no immediate access to the electricity grid. Jon says research by University of Southern Queensland's Dr Joseph Foley in 2015 found 90 per cent of direct energy use for irrigation is provided by diesel fuel.

"These findings across a sample of 158 cotton farms in this instance found a median emissions per bale from all energy use of 91 kg CO2e, with groundwater irrigators contributing to the higher end of the sample range of 25 to 200 kg CO2e per bale due to increased pumping," Jon said.

"Diesel is a critical input into a highly mechanised cotton system and there are unfortunately very few alternatives that can supply power on demand to drive pumps and operate machinery.

"Since the study was commissioned, global energy markets have doubled in price, so previously considered 'tardy' paybacks on investment for integrating solar PV into pump sites will be looking a whole lot better today, without acknowledging or factoring in a recent surge in Australian carbon credit unit price for carbon abatement at the same time."

In this study Ag Econ assessed the costs and benefits of installing a FPV system across three scenarios, based on a case study farm at Goondiwindi (Bigambul country).

The first two scenarios considered installing a small-scale FPV system sized to help serve the energy demand from a nearby bore or lift pump adjacent to the water storage in an on-grid scenario and in an off-grid scenario.

The study showed the investment offers a real internal rate of return (IRR) of 14.8 per cent in the on-grid scenario and 11.9 per cent in the off-grid, diesel-powered scenario. The returns rely on and

are sensitive to several key assumptions, including the costs of the floating structures and the projected future cost of energy, such as diesel fuel.

Whilst the benefits from reduced evaporation from a small-scale FPV system contribute to the investment returns, the water savings are small compared to the total size of the water storage. The emissions intensity per bale of cotton improves by 28 kg CO2e per bale in the off-grid scenario and by 59 kg CO2e per bale in the on-grid scenario.

While the evaporation savings contribute to the financial returns, they are not significant in terms of the size of the water storage, mostly due to taking up a very small proportion of the total 42-hectare surface area. In both scenarios, emission intensity per bale of cotton improves substantially when the FPV system is integrated into irrigation pump sites.

"Considering other studies assessing the Life Cycle Assessment (LCA) of pre-farmgate cotton practices, these results show integrating renewable energy can reduce the per bale carbon footprint of cotton in some pumping scenarios," Ag Econ's Janine Powell said.

"When we undertook the study, the first two correspond to a seven to eight-year payback on the upfront investment, however as mentioned, with global energy markets doubling in price, this period has decreased."

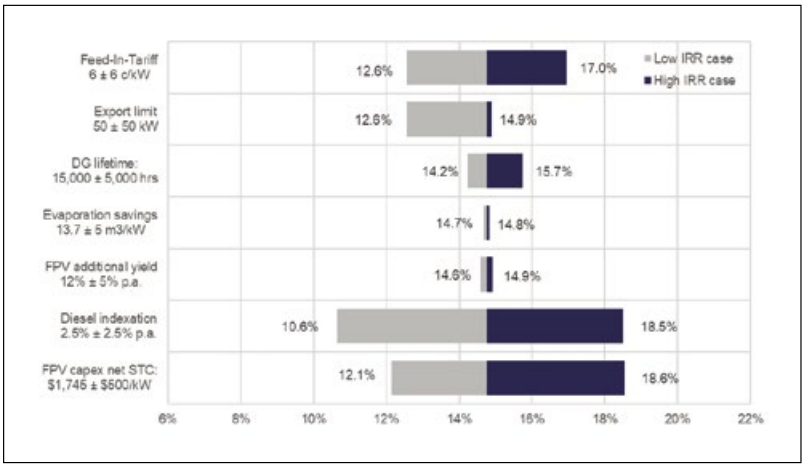
The third scenario considered the potential for a large-scale FPV system that covers the entire water storage for the purpose of selling to the market. The results indicate potential economic benefits of $223,000 per year over the 25-year life of the FPV system from water savings when the gross margin value of water is used. However, a large-scale FPV system requires significant capital investment, expertise and proximity to the electricity transmission network and would likely need to be built and operated in partnership with a renewable energy developer.

The study suggests that approximately 525 megalitres of water could be saved from evaporation per year through a 42 MW FPV system.

"These water savings could be worth up to $223,000 per year using the water gross margin of furrow irrigated cotton," Jon said.

"However, the costs and complexity associated with developing and operating a large-scale FPV system are significantly higher than for a small-scale FPV system, and a cotton irrigator would likely do this in partnership with a renewable energy developer.

"These results show integrating renewable energy can reduce the per bale carbon footprint of cotton in some pumping scenarios."



IRR sensitivity, small-scale on-grid scenario, base 14.8%.

CRDC has investigated various mechanical, biological and chemical approaches to reducing storage evaporation. CRDC R&D Manager Elsie Hudson says this study provides valuable insights, including potential areas of future research, and potential collaboration opportunities with renewable energy developers on systems that are either grid-connected or that have a clear alternative use case for the solar production.

"A practical and economical solution to mitigate evaporation from on-farm storages remains elusive," Elsie said, "which is why CRDC has supported this economic analysis of FPVs, and why we have recently called for research partners to look at alternative solutions and technologies to mitigate evaporation.

"FPVs tick a few boxes as we move to develop more renewable energy systems, which often take up valuable cropping land. Along with cotton's aim to reduce emissions under our Sustainability Framework, and the rise in diesel and electricity prices, growers are investigating ways to find gains and save costs where possible. As a result, renewable energy options are being increasingly explored.

"It also gives us something to think about in terms of the anticipated add-on of green hydrogen technologies at a small industrial scale with multiple use-cases, although the cost and other aspects such as storage and safety are largely unknown at this stage."

For more
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More than 50 cotton growers have already signed up to work with SHIFT in an effort to solve workforce issues.

Industry workforce initiative focuses on employers

A new workforce development framework, called SHIFT, has been created by the cotton industry, for the cotton industry, to achieve high performance, engagement and satisfaction for both employees and employers.

SHIFT focuses on the employer, helping growers to attract and retain team members by being an 'employer of choice'. It's part of a CRDC-supported project, *Delivering Best Practice for Management of Future Skills,* led by Central Queensland University (CQU) researcher and psychologist Dr Nicole McDonald.

"Best practice people management is about worker engagement, job satisfaction and retention, and leading teams through change – like learning and using new technology, ," Nicole said.

"Cotton's own research backs up the findings from the recent Australian *National Agriculture Workforce Strategy*, which shows that it's the 'human' aspect of businesses – cotton and otherwise – that will be a major factor in determining whether we're disrupted by changes in the economic, environmental, or social landscape, or whether we can position ourselves to benefit and thrive into the future."

The principles of SHIFT are based on Nicole's previous CRDC-supported research *Contextualising the Future of Work in the Australian Cotton Industry*. It found that while the future of work is never certain, several trends are shaping changes in cotton: including the rise in digital technologies, increasing environmental constraints, and shifting societal demands. An ability to adapt, respond, and capitalise on these trends will determine the ongoing survival of the cotton industry.

As part of the study, case studies were developed which explored the personalities, traits, abilities, skills and structures that enabled people in the cotton industry to embrace positive changes that improved the economic, environmental, and social sustainability of their work.

"From my prior research we have identified areas for development, and these have formed the five pillars of our program: Social sustainability, Human sustainability, Innovative workplaces, Future focus, and Transformational leadership (SHIFT)," Nicole said.

"Through addressing these pillars, and delivering a suite of resources and tools to support cotton's workforce attraction, retention and development, we will ensure cotton is future-fit."

Nicole's SHIFT team includes leadership specialist Jo Eady of Ruralscope (known to many in the industry for her facilitation of the Cotton Future Leaders Program), CRDC-supported PhD student, psychologist and cotton grower Chantal Corish, and Dr Amy Cosby who leads the agriculture education and extension research team at the Central Queensland University Institute for Future Farming Systems.

"There are future-of-work reports available that forecast how change might happen broadly, but it's really important that we deep dive into the actions that drive these changes and what they look like in the cotton industry," Nicole said.

"The case studies showed practical ways that different businesses are preparing for and shaping the future of work. This includes working with agricultural colleges, creating a culture of care, recruiting locally and encouraging further education or skills development.

"Through the interviews we analysed the data to identify teachable and trainable factors, organisational structures and ideas that could be transferable to other businesses."

The current phase of the SHIFT project is focused on developing the pilot program and extension resources.

"We know growers are experiencing different workforce challenges at the moment and we want to hear from them and to work with them to find solutions. We don't just want this to be a research exercise: we want it to work in practice on cotton farms, which requires grower input and collaboration."

Growers who are interested in working with the research team are encouraged to contact Nicole.

For more

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Taking care of business means taking care of people

Recruiting locals, upskilling himself and his staff, and supporting agricultural scholarships are just some of the methods Rob Davies uses to maintain a happy and healthy workforce. Rob was involved with Dr Nicole McDonald's research to develop SHIFT – the cotton industry's workforce program to create an industry brimming with 'employers of choice'.

Rob oversees his family's property 'Myall Park' at Blackville on the Liverpool Plains (Kamilaroi country) on behalf of Dalara Pastoral, where they grow dryland cotton, winter crops and cattle.

Rob was a finalist in this year's Australian Cotton Industry Awards AgriRisk High Achiever category, in part for his management structure. The family have a clear succession pathway guided by a core value that they are 'custodians' of their family business, as opposed to 'owners' of it, which informs a lot of their decisions around workforce development.

A custodian mindset helps Rob to take a strategic view of the farm business and the value of 'care' extends from the business through to people management and sets expectations for job performance standards. Clear structures and values that facilitate good communication, team functioning, and support of upskilling means people know what is expected of them, how they can be a good contributor to the business, and have the opportunity to progress, which makes them valuable members of the team.

Dalara Pastoral consists of a number of workers who have been associated with the business from the start. Knowledge of local environmental conditions is strongly valued, and Rob recognises that a workforce with ties to the community brings a greater likelihood of retention, as the team have built local relationships and fulfilling lives.

Real world experience is essential beyond any formal training at tertiary institutions.

"You can sit in a classroom for as long as you like, but if you don't have the on-farm training and experience with the seasons and the weather patterns, and if you don't know what the crop's doing, that piece of paper doesn't matter to us," Rob said.

"Essentially, we're looking for that environment skillset: it's really important to get that right."

Rob takes the same approach to upskilling his staff as he does himself.

"As managers, we are always looking to build our own skillsets and knowledge," Rob said.

"I think it's very important for the cotton industry to be offering plenty of training programs and development opportunities, and the onus is on the farmer to allow employees to attend this type of training.

Rob Davies worked with cotton researcher Dr Nicole McDonald to provide a snapshot into different people management styles among cotton growers.

"At a base level, all our employees do a chemical and a first aid course, and we fully support staff undertaking any qualification or further education in the ag sector that they want to pursue. We give them time off to do that."

Staff are managed to complete their work in alignment with the workplace values of 'caretaking' and have clearly-communicated high performance standards set for them. The accomplishment that comes with this helps to develop their intrinsic motivation. Supporting them to feel valued and to know that their efforts matter adds to this sense of satisfaction.

"We encourage people to think about the task at hand and not rush through it," Rob said.

"We always try to finish the job we've started, pending situations like weather. We like to get one thing tied up so it's complete and it's all in sync as it gives everyone a good feeling. Staff can look

around and feel proud that they've been a part of what has been achieved and how the place looks."

Support extends beyond developing staff competency and valuing their work, to also care for their wellbeing.

"Health and wellbeing is also clearly important," Rob said.

"We offer annual comprehensive health checks for our managers, and considering options for other staff members moving forward, so our team can keep on top of their game and make sure they're fit and healthy.

"We want people to have a quality life at work and a quality life at home, just as we want that for ourselves.

"Family and a supportive working environment are huge for our business. Giving people time off to go and see their kids play sports and all that sort of thing is one of the bigger parts of our business."

Dalara Pastoral also sponsors a scholarship for students at Marcus Oldham, where Rob studied, to introduce the next generation to cotton and/or livestock. This provides a pathway to the cotton industry, particularly for those students with no prior exposure to the industry. The scholarship expands the students' professional network, familiarising them with the environmental conditions of the farms the Davies family manage, and giving them the experience of living in cotton farming communities.

"It gives us a gateway to that next generation," Rob said. "Students come on farm and we try to rotate them through the various operations to give them experience. We spend time with them, provide on-farm training, and give them a good on-farm experience."

SHIFT project lead Dr Nicole McDonald says Rob and his family strategically take action to ensure a sustainable farming business that will endure and grow into the future.

"Rob and his family have structures set-up that value diversity of thought in decision making," Nicole said.

"Their approaches to attraction, hiring, developing and retaining their workforce, plus the values that set the workforce culture, add to the social sustainability of the business. Sustainability is also clear in the way succession pathways are clearly defined to progress within the family business.

"Rob's approach is also more than time management: it's energy management.

"It is not simply about where people are and what they are doing, but how present and attentive they are in all domains of their life: work and home.

"This approach empowers people at work, while also enabling quality engagement with family while at home.

"It recognises the importance of time away from work, so an individual can then bring their best self to the job."

That fact that most of their core staff have been with Dalara since the beginning and/or nearly the whole time, Rob said he feels as though their strategies are working.

"In terms of filling positions this is partly covered by our scholarship at Marcus Oldham were we like the student to choose an area of preference which is either at Blackville for farming side or up at our New England property near Walcha, which is purely grazing.

"We find that most have a direct interest in cattle and sheep so two-thirds of them would be based at Walcha. This is also a natural fit for us as our management team at Walcha are always chasing some younger staff due to energy levels required with sheep.

"In terms of when we need to fill 2IC roles or new higher management positions as our business grows, traditional methods of advertising through local and regional papers or even social media can come with mixed reviews.

"As we expand, we will either engage a recruiter to help with that process and/or use word of mouth.

"We have a website which is being updated currently and I have just opened up an Instagram page for our business.

"Once these are up and running properly the interested candidates can use these to almost vet us as we would to them.

"We are hoping to paint a picture to make this type of recruiting and easy process for all parties."

Rob and the team at Dalara Pastoral are growing dryland cotton on the Liverpool Plains at Blackville (Kamilaroi country).

For more
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Celebrating 30 years of creating the foundations for leadership

Based on the proviso that the success of a community or industry lies in the capacity and willingness of individuals to become leaders, the Australian Rural Leadership Foundation (ARLF) was founded 30 years ago, with the specific aim to develop leaders for rural, regional and remote Australia.

The idea for ARLF came out of the then newly formed Rural Industries Research and Development Corporation (RIRDC) – now known as AgriFutures Australia, CRDC's fellow research and development corporation – which was looking at how to encourage the development of new rural industries, support existing industries and create thriving communities.

Not least of these was the Australian cotton industry and the communities it operates within. RIRDC's Board identified that a key difference between successful rural communities and those perceived as struggling was not due to inherent natural resources or strategic position, but to an individual or group of individuals. These individuals were standing up and taking on leadership roles.

The resolution was that leaders were required, not only in state and national political roles, but within local schools, on hospital boards, within community and sporting groups, and local industries. With that, the ARLF was formed, as an organisation that could influence change across Australian rural industries as a whole, and rural communities in general.

Today, ARLF runs the Australian Rural

The road to leadership involves an experience in the Kimberley (Gooniyandi country) that ARLP participants say offers many defining moments.

Leadership Program (ARLP), Australia's longest-running and most in-depth experiential leadership program for rural Australia, which this year has celebrated 30 years.

Applying to the ARLP is competitive and rigorous, and those selected attend 50 days of experiential learning and mentoring across four sessions over a 15-month period, under the ARLF remit to nurture and advance rural Australia: to take an ethical approach; challenge assumptions; and seek to respectfully influence change for the greater good of Australia.

The cotton industry has supported participants in 28 of the 30 cohorts. There have been 44 cotton industry participants in total supported variously over the years by CRDC, Cotton Australia, Auscott/Australian Food and Fibre, Twynam Pastoral, Namoi Cotton, Cotton Seed Distributors, Cotton Grower Services, Paraway Pastoral and Prime Super.

Two growers in the first cohort (1993-94) were Mike Logan, who went on to become CRDC Chair, and fellow Namoi Valley (Kamilaroi Country) grower Jack Warnock, a stalwart who has served on many groups associated with the industry.

Many graduates from the cotton industry, like Mike and Jack, have gone on to help lead it. They include Cotton Australia CEO Adam Kay, former CRDC Executive Director Bruce Finney, former CRDC R&D Manager Bruce Pyke, current CRDC General Manager of R&D Investment Allan Williams, CRDC Executive Manager of Communications Ruth Redfern, CSIRO entomologist Dr Sharon Downes, growers and Cotton Australia/CRDC board members and growers Barb Grey, Liz Stott and Fleur Anderson. This year's Incitec Pivot Fertilisers Service to Industry Award recipient Bernie George is also a graduate of ARLP. Current participants are growers Aaron Kiely and Jack Brennan, who will graduate from course 29 in 2023. The course 30 participants will also be announced in 2023, with CRDC, Cotton Australia and Australian Food and Fibre co-sponsoring up to two cotton industry leaders to take part.

For more

Australian Rural Leadership Foundation

https://rural-leaders.org.au

The ALRP Kimberley experience is often described as the most lifechanging aspect of the program. Pictured is CRDC's Executive Manager of Communications Ruth Redfern during course 27 in 2021.

Cotton ARLP alumni in chronological order, from 1993-94 to 2022-23.	
Jack Warnock (course 1)	Dallas King (course 16)
Michael Logan (course 1)	Arthur Spellson (course 17)
David Anthony (course 2)	Paula Jones (course 19)
Adam Kay (course 2)	Brooke Summers (course 20)
Bernie George (course 3)	Elizabeth Stott (course 20)
Paul McVeigh (course 3)	Bronwyn Christensen (course 21)
Allan Williams (course 4)	Sharon Downes (course 21)
Bruce Pyke (course 4)	Tobin Cherry (course 21)
Harvey Gaynor (course 5)	Jamie Iker (course 22)
Peter Cottle (course 5)	Sean Boland (course 22)
Bruce Finney (course 6)	Matthew Bradd (course 23)
Michael Egan (course 6)	Meagan Laidlaw (course 23)
Kerry Gibson (course 7)	Timothy Chaffey (course 24)
Scott McCalman (course 7)	Richard Malone (course 24)
John Hamparsum (course 8)	Fleur Anderson (course 25)
Stefan Henggeler (course 8)	John Durham (course 25)
Philip Armytage (course 9)	Chantal Corish (course 26)
James Houlahan (course 10)	Rod Gordon (course 26)
James Gow (course 12)	Ruth Redfern (course 27)
Ben Stephens (course 13)	Justin McMillan (course 28)
Mark Morton (course 14)	Aaron Kiely (course 29)
Barb Grey (course 15)	Jack Brennan (course 29)

Leadership for the greater good

Spotlight editor and CRDC Executive Manager of Communications Ruth Redfern says the Australian Rural Leadership Program (ARLP) exceeded all expectations.

Allan Williams has been an industry leader in many aspects, from working to develop the industry's first BMP program, to chairing ICAC's Expert Panel on the Social, Economic and Environmental Performance of Cotton (SEEP) where he has represented the cotton industry and Australia throughout the world.

After graduating from the ARLP in early 2022, Ruth now manages CRDC's investment in the cotton industry's leadership programs, including the ARLP and the Australian Rural Leadership Foundation's emerging leaders program, TRAIL; the Australian Future Cotton Leaders Program with Cotton Australia; and the Nuffield Australia Farming Scholarship.

In applying for ARLP, Ruth says she saw the course as an opportunity to do four things: learn, grow, be challenged, and to shape her path forward in terms of contributing to the future of rural, regional and remote Australia. Having completed the program, Ruth said it was a powerful learning experience.

"I graduated from ARLP with a huge number of personal learnings: plus some that are really valuable in my role in the cotton industry. The biggest is that leadership is about a purpose bigger than us as individuals. It's about being in the service of something greater, and contributing to the greater good.

"For me at CRDC, the greater good is helping the industry achieve social, economic and environmental sustainability. It's about ensuring we really are 'here for good'."

In their words: ARLP Fellows

Spotlight caught up with some of cotton's 44 ARLP alumni. They were asked 'how does the course inform what you do today and what did you learn about yourself in terms of leadership?'

Allan Williams, CRDC General Manager R&D Investment
"I carry with me the importance of listening to everyone in the team when looking for solutions, and in terms of leadership, not trying to be someone I'm not."

Harvey Gaynor, former Auscott General Manager
"The lessons I learnt about how teams come together, develop and operate well are constant reference points for me whenever I'm leading or playing a part in a team. And the wide network of the ARLP is something unique that I'm fortunate to be woven into. I learned to accept and work with the calm style of leading that I naturally fall to, and then to try and hone the use of more emotion when the situation needs it. 25 years later I still feel as though that's a work in progress!"

Barb Grey, former cotton grower and Cotton Australia board member
"Essentially, I've continued to walk-the-talk with my value system. The course taught me too much to distil in a few lines, but we all learn by doing; and never assume."

Dr Sharon Downes, CSIRO entomologist
"I now consider how a person's recent and former experiences might be influencing their actions today, and actively engage with others especially those that on face value might appear to have little to offer. I learned to trust instincts and speak up when I had something to say – because everyone has something to offer, even if it might sound 'stupid' in the privacy of your head!"

Jamie Iker, agronomist and recent chair of Crop Consultants Australia
"Being exposed to and engaging with a range of leaders allows for a broader mindset when it comes to leadership which is critical, I believe, to becoming an effective leader. I have forged relationships and friendships that will last a lifetime and a belief and understanding of myself that could only have occurred through this process."

Chantal Corish, cotton grower, psychologist and industry researcher
"The ARLP course gave me a greater sense of determination and persistence that comes with self-belief; and more confidence in understanding how others need to me to show up when I am part of a team. It reinforced my values around psychological safety and the need for more leaders to grasp this important notion of building a culture that allows everyone to feel heard and able to confidently learn, develop, contribute to their full potential."

Becoming who you truly are

Jack Warnock was sitting on a tractor doing some laser bucket work on his Maules Creek (Kamilaroi country) farm in early 1993 when he heard someone talking about the ARLP on the radio.

Jack and Jacqui Warnock have spent their lives involved in the cotton industry, and Jack says the ARLP gave him greater confidence to expand and grow his business.

"I heard them mention the Kimberley experience as part of the course and that hooked me, as I had been there in the early 70s looking at irrigation as part of a Royal Agricultural Society (RAS) scholarship," Jack said.

Jack, who only recently retired from farming, and then fellow Narrabri (Kamilaroi country) cotton grower Mike Logan became the first cotton industry participants in course one of the ARLP.

"I rang up and applied and later Mike and I drove to Dubbo together for the interview," he said.

"I was certain Mike would be accepted, but was excited when we both got the nod."

Jack says in those early days, the experience provided confidence, to accept and embrace change, and personally gave him the confidence to expand and develop his farm and put his hand up for other roles within the community.

"You change as part of the ARLP experience. It helped me become who I am," he says.

"ARLP taught me that it's better to be in the room rather than throwing rocks from the sidelines. So in more recent years, I've worked in community consultative groups on gas and water.

"I even had a brief foray into politics in 2003, as I'm of the opinion that if you have a view put your hand up."

Jack was already a leader prior to the course. He was a board member of Namoi Cotton and Cotton Australia and was heavily involved in the water reform process in the Namoi Valley. He'd also undertaken a significant research project.

"I was an agronomist-in-training at Trangie working for NSW DPI and won the RAS scholarship studying irrigation around Australia.

"I travelled extensively for nearly 18 months, looking at every possible aspect of irrigation. I funded a lot of the travel myself, as I wanted to know as much as possible about irrigation and water.

"Then through the ARLP course, which I undertook later, you get to understand a lot more about your personality and where you fit in the world."

All participants, including Jack, say the connections that are made with others are long lasting.

"Thirty years on, I still stay in touch with some of the people in that first course and have become good friends with some," he said.

"Wesley Hazel from Tasmania and I went back to the Kimberley in 2013 for the 20-year reunion and then stayed on to relive the experience, visiting places and doing activities that were a part of course one.

"ARLP instils values of confidence and preparedness to have a go, along with the value of communication and being a part of a broader community with industry, by developing an understanding of other leaders and their experiences."

Mike Logan says if there is one word that he has come to depend upon from the program it is 'process'.

"I have learnt that if I can supply a way, a series of steps, a process, then shared solutions can be discovered," Mike said.

"It is clear to me that a problem, or challenge that is well understood, then it is already mostly solved.

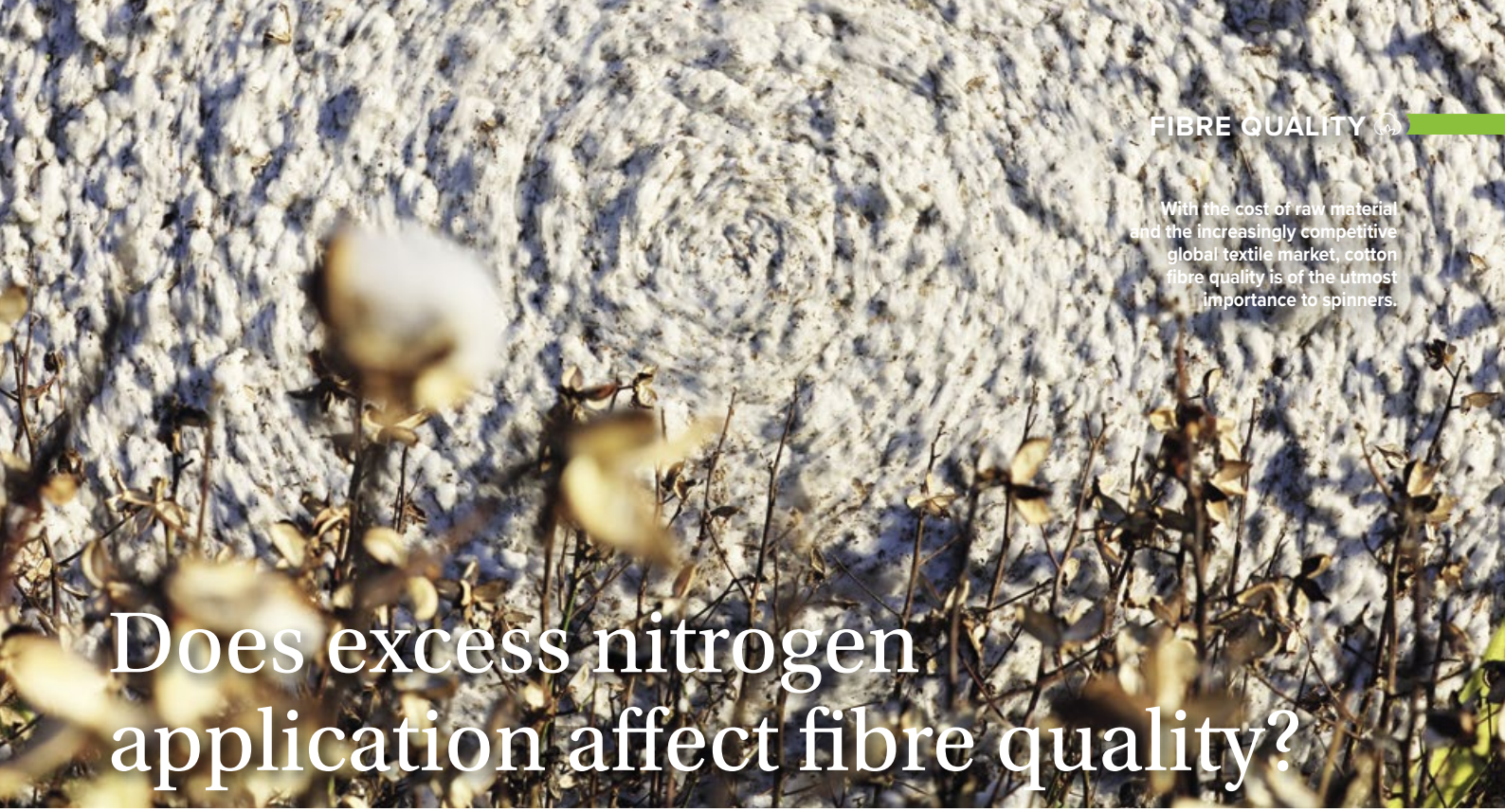
"Providing a process to achieve understanding is my key learning."

He says in terms of his own leadership, he's learned about patience.

"We all have an innate need to solve the problem, but the leader shouldn't always have the answers.

"We need to have the patience to have the questions. Rudyard Kipling put it well in *The Elephant's Child*."

'I keep six honest serving-men:
'(They taught me all I knew)
'Their names are What and Where and When
'And How and Why and Who.'



With the cost of raw material and the increasingly competitive global textile market, cotton fibre quality is of the utmost importance to spinners.

Does excess nitrogen application affect fibre quality?

MELANIE JENSON

Colour, lint turn-out and sticky cotton are the three factors most influenced by high nitrogen (N) application rates, according to a major industry review, recently published in the Journal of Cotton Research.

Undertaken by long-term cotton researcher and current CottonInfo Fibre Quality Technical Lead René van der Sluijs, with support from CRDC, the review has filled a knowledge gap in terms of the relationship between N and fibre quality.

"Colour, lint turn out and sticky cotton are heavily influenced by the application rate of N, with the colour of the fibre becoming less bright and duller, a reduction in lint turn out, and increased susceptibility and insect attractiveness with increased N application rates," says Rene.

"Fibre length and length uniformity, strength and micronaire were all less impacted by the N application rate, which is unsurprising as length and strength are primarily genetic traits, and micronaire primarily attributed to weather and management."

The effects of N on plant growth, health and yield have been widely studied, with practical guidelines, decision support systems, models and reviews providing information on the importance of providing crops with a sufficient supply of nutrients while optimising N use efficiency (NUE). Australian best practice, based on significant CRDC-supported R&D, has found that N application in excess of 250kg/ha shows no significant yield benefit.

"We know that excess application above NUE has no economic benefit – with this review, we now also know it can negatively impact fibre quality," René says.

"With financial return to the grower dependent not only on quantity but also quality, we were aware that only a limited number of studies have been published around the effect of N on quality.

"We also know that due to the greater demands of modern spinning, in terms of speed and automation, the cost of raw material and the increasingly competitive global textile market, cotton fibre quality is of the utmost importance to spinners."

Growers are well aware of the most important physical properties required by the spinning industry which include fibre length, length uniformity, strength, micronaire (a combination of maturity and fineness), colour and trash. Colour has the greatest impact on the price of cotton, followed by cleanliness/trash content, micronaire, length and strength. All of these factors were assessed in terms of the affect of N application.

In terms of fibre length, the review findings were varied. The majority of the studies conducted for the review concluded that increased application rates of N had no significant effect on length, with a few studies finding no clear trend. There were also some studies that found that N application rates either had a positive (increase) or a negative (decrease) effect on fibre length. The results were similar for strength, with some studies finding no trend, with some studies finding that N application rates either had a positive (increase) or a negative (decrease) effect on fibre strength. Micronaire was similarly affected.

Of importance to cotton growers and marketers are studies showing that increased N application results in increased populations of aphids and whitefly, the two insects most responsible for sticky cotton due to honeydew secretions. Excess N can also result in resistance to standard control measures for a range of cotton pests, which can lead to increased applications and the use of more products that can be harmful to beneficials insects.

"Cotton stickiness can present a major problem in terms of textile processing performance, cost and product quality," René said.

"The sticky deposit adheres to any machine part or surface encountered by the cotton along the processing pipeline, causing an accumulation of fibres (and even dust or grit), during the ginning and spinning processes. It can also cause issues during cotton classification, with deposits on the combs used in HVI instruments resulting in incorrect and inaccurate fibre measurements."

For more

Journal of Cotton Research article

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Preparing for genes of biosecurity concern

When we think about biosecurity, newly arriving species from overseas are often seen as the key threat. However just as likely to have an impact are some key pests of cotton currently found in Australia, should additional, undesirable genes arrive.

These are knowns as 'genes of biosecurity concern', which means the species may already be here in Australia, but if new genetics arrive then the impacts of those species may be greater.

One of these concerns for the Australian industry is that new Bt resistant genes in *Helicoverpa armigera* – currently found in Asia – could arrive in Australia. The new genes are dominant and therefore may evolve more quickly. Beyond assessing the threat and likelihood that such an incursion may occur, the Australian cotton industry also needs to consider how the best response aligns with current industry risk management practices.

A CRDC-supported research project involving CSIRO scientists, plus collaborators from China, is comparing the Australian and Chinese Bt Resistance Management Plans (RMPs) to gain insights through computer simulation models. It aims to provide preliminary recommendations on how to prepare for an incursion in Australia of *H. armigera* that carry dominant Cry1Ac resistance genes.

The project is being led by CRDC's fellow research and development corporation, Hort Innovation, with support from CRDC and the Department of Agriculture, Fisheries and Forestry's Rural R&D for Profit program, and delivered by CSIRO's Health and Biosecurity Business Unit.

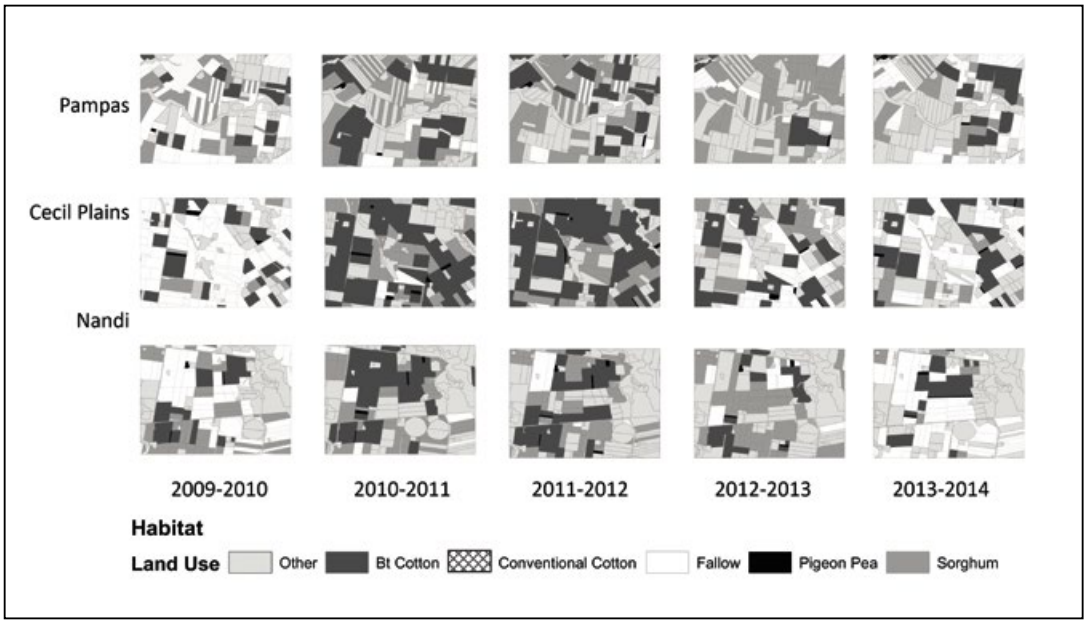
What do the models tell us?

CSIRO's Dr Hazel Perry said the research team have developed a model for the Australian situation and compared the trends with similar models developed for the situation in China.

"We found that single gene *Bt* technology (as currently found in China) is likely to be much less effective in managing the spread of dominant resistance than the pyramided traits in Australia," says Hazel.

"This is particularly the case if we were to simply rely only on the five percent mandated refuges in the landscape as outlined in the industry's RMP.

"In reality, there is typically somewhere between 25 and 75 percent of Australia's cotton landscape that is acting as an effective or 'natural' refuge, for example in regions such as Queensland's Darling Downs, where sorghum crops in particular add to these figures.



There is typically somewhere between 25 and 75 percent of Australia's cotton landscape that is acting as an effective or 'natural' refuge. In regions such as Queensland's Darling Downs, where sorghum crops in particular add to these figures.

"When this habitat is considered, the concern of resistance evolving is far less, regardless of whether the gene is dominant or recessive, even if part of our current pyramid technology were to be overcome."

CSIRO's Dr Sharon Downes is also working on the project and says fitness costs (ie. increased pest mortality due to carrying resistant genes) don't seem to impede the rate of resistance evolution in the models.

"It's worth noting that much of the model scenario analysis was based only on within-season dynamics: we are yet to explore complex processes of diapause and overwintering which may impact resistance evolution as well as best practice for management," Sharon said.

Key recommendations

Using insights from the models along with the comparison of RMPs for Bt crops in Australia and China, the research team are developing some key guidance for the Australian situation.

"Monitoring should be continued for the evolution of resistance alleles over space and time – this is the best way for early detection of any genes of biosecurity concern," Sharon says.

"Current RMP strategies in Australia should also be maintained, noting that refuge strategies are likely to be equally effective if resistance is dominant rather than recessive.

"The interaction of refuges with a pyramid makes them much more effective, including when resistance is dominant. The suppression effect of un-mandated 'natural' refuges is important to consider."

Fitness costs cannot be assumed for a dominant resistance and may not be present or slow down the spread of the resistance gene throughout the landscape. It is critical to understand existing cross-resistances and multiple-resistances upon any new genes of biosecurity concerns being detected.

"We need to estimate the between-season survivorship of *H. armigera* in China and Australia, to inform the potential value of planting windows and pupae busting which are currently elements of the RMP that could be strengthened if required," project lead Dr Wee Tek Tay said.

"Current RMP strategies in Australia should also be maintained, noting that refuge strategies are likely to be equally effective if resistance is dominant rather than recessive."

MELANIE JENSON

The cotton industry is alert to the potential for known pests such as Helicoverpa coming to Australia which carry resistant genes not present in current populations.

"We also have recommended that integrated pest management (IPM)-compatible non-Bt control tactics should be considered as control options for *Helicoverpa spp.* for managing any resistances to Bts."

What should we be doing now to prepare?

Research has alleviated some fears and there is no cause for immediate alarm, even if dominant Bt resistant genes 'invade' Australia from overseas.

"We have strategies in place with refuges and pyramid technologies as well as benefit from 'natural' refuges, that mean resistance is unlikely to evolve any faster than it currently is, according to insights from the available models," Sharon said.

"However, there are gaps in our knowledge: to fully understand risks we need to know more about cross-resistances, multiple-resistances and fitness costs, as well as how diapause and overwintering may impact resistance.

"If risks are higher than we currently believe, particularly if they relate to between-season survival, our strategies may be strengthened with additional management options such as tighter regulations around pupae busting and planting windows.

"The use of IPM compatible non-Bt control tactics will be complementary and of benefit in any scenario."

For more
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Collaboration between CRDC, Bayer and CSIRO is enabling the Australian cotton industry to better understand key issues around resistance to Bt technology.

Maintaining the integrity of Bt

The introduction of Bt technology revolutionised the cotton industry in terms of pest control and integrated pest management (IPM), however the technology is not a set-and-forget weapon. Work is continuously underway to maintain the integrity of the technology and develop aspects of resistance monitoring research to create an industry that can act rather than react to any signs of resistance developing.

Under a CRDC, Bayer and CSIRO project, research scientist Dr Amanda Padovan and her associates at CSIRO have developed two tools for molecular resistance monitoring of Bt resistance in *Helicoverpa spp*.

It is hoped that the molecular tools can be used in conjunction with the traditional bioassay resistance monitoring currently undertaken by Bayer to support the cotton industry, increasing the number of insects able to be tested by increasing the speed and decreasing the hands-on time for each assay.

Traditional bioassay monitoring will continue alongside this trial to continually calibrate these new molecular tools.

The first new molecular tool is a PCR-based method to detect known resistance alleles, as the current F1 bioassay is designed to do. The PCR tool offers a quicker way to assess resistance and allows researchers to test one insect for multiple types of resistance to Cry1Ac, Cry2Ab and Vip3A found in transgenic cotton varieties.

Maintaining the integrity of Bt technology is vital to the ongoing success of the Australian cotton industry's IPM system.

"Bt cotton has become the foundation of cotton's IPM system, and by managing Helicoverpa, the industry has been able to focus on developing methods to control other insects: those that emerged as key pests after transgenic varieties knocked Helicoverpa from the number one spot," Amanda said.

"It has led to easier integration of non-chemical IPM tactics, much less reliance on pesticides to control Helicoverpa, and the use of more selective pesticides for use when we need them to control other pests."

As a part of the project a whole genome sequencing method was developed to detect known resistance alleles and possible resistance alleles in known resistance genes. This will provide the Australian cotton industry with an additional level of preparedness in the event of a novel resistance mechanism developing in Helicoverpa. A database of genetic data has also been built that can be used for surveillance and genomic prediction of novel resistance mechanisms.

"This gives us a way to detect novel Bt resistance alleles in the field, which means we'd be able to react early with supplementary control measures in the hope of eradicating that specific resistance mechanism before it spreads through the population," Amanda said.

CRDC, CSIRO and Bayer are working together to test these methods in real time throughout the growing seasons. The whole genome sequencing method has been developed in the lab, with the research team evaluating its efficacy in the field over the coming seasons.

"This year was all about establishing the technical skills at all sites which we have completed," Amanda said.

"Now we are planning how to fit the molecular tools into the workflow of resistance monitoring for next season.

"We will run a real-time test of the molecular tools in the 2022-23 season but will also use conventional resistance monitoring to compare the molecular tools to bioassays in terms of resistance detection.

"We are very optimistic about these tools and hope to show that they can streamline the process of resistance monitoring."

Dr Kristen Knight (pictured) is part of the CRDC, CSIRO and Bayer team working on a whole genome sequencing method that has been developed in the lab. The team will be evaluating its efficacy in the field over the coming seasons.

MITCHELL ROBERTS

For more

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Scientists uncover mystery of Verticillium

Australian scientists are leading the way in better identifying and describing the strains of *Verticillium dahlia* and the levels of damage they cause in cotton crops.

Verticillium dahliae is a highly destructive soil-borne fungal plant pathogen that has developed many strains capable of infecting and damaging more than 400 host plant species around the globe, including cotton. CRDC and partner organisations have supported research which has successfully increased knowledge around many aspects of the disease Verticillium wilt, including its biology, how it spreads, its hosts and how to manage it.

Australian cotton growers have felt the impact of Verticillium wilt in recent years, and at the same time, cotton industry molecular biologists have uncovered strains (referred to as vegetative compatibility groups – VCGs) not previously known to be in Australia, such as VCG1A in 2016 and VCG6 earlier this year. They've also answered questions as to why apparent 'non-defoliating' strains of the pathogen in cotton were seen to be causing defoliation.

NSW DPI's Dr John Webster worked in collaboration with Dr Karen Kirkby, the lead researcher of the *Managing Verticillium Risk for Cotton* project, supported by CRDC and the Department of Agriculture, Fisheries and Forestry as part of its Rural R&D for Profit program. John and Karen used molecular techniques to look for answers.

"We have two different types of disease, defoliating and non-defoliating, in Australian cotton. You can see symptoms of the disease on a plant, but it requires a genetic test on the isolate to determine if it's defoliating or non-defoliating," John said.

"Generally, these two types of disease are consistent with what strains are seen, for example: VCG1A strain is defoliating and VCG2A is non-defoliating."

Until now, it was thought the most significant damage caused by the Verticillium pathogen was from the VCG1A group. However, John and his team discovered a defoliating-like VCG2A strain that also causes severe disease, unlike its other non-defoliating VCG2A counterparts.

MELANIE JENSON

Research has helped growers manage Verticillium, identifying corn as a suitable rotation crop to inhibit the build up of the pathogen in the soil.

"You can imagine our surprise when we had an isolate we had identified as a non-defoliating VCG2A based on the genetic test, but it was causing severe disease symptoms in plants," John said.

"This hadn't been seen in any other country before, so my goal was to have a look into the genome of this isolate and see what it has that the regular VCG2A doesn't have, as that difference might be what makes it more severe.

"We found a strain of VCG2A that tests negative for the defoliating test but causes a severe disease resulting in defoliation which is why we've termed this strain 'defoliating-like'".

"The genetics in how this 'defoliating-like' isolate obtained this ability is really interesting, but still unknown, as Verticillium is not known to sexually reproduce – the usual method in which

new combinations of genes occur in subsequent generations."

John and his team identified 20 proteins present in defoliating isolates (VCG1A and the 'defoliating-like' VCG2A) and absent in non-defoliating VCG2A isolates.

"Interestingly, half of the proteins identified in the 'defoliating-like' VCG2A isolate were most closely related to those found in the VCG6 isolate from Noogoora burr," he said.

"The sexual stage of *Verticillium dahliae* has not been observed and it is thought that most exchange of genes happens between isolates that share a VCG group.

"VCG6 isolates are rare and thought to have arisen by an unknown genetic exchange mechanism.

"A mechanism that is perhaps involved in the transfer of virulence to other *V. dahliae,* such as the 'defoliating-like' VCG2A seen here."

Karen says the role of Noogoora burr in Verticillium spread and severity was previously reported in the 1970s, along with research on the influence of weed hosts on the ecology of Verticillium strains in newly cultivated areas of the Namoi Valley (Kamilaroi country). Since then, Noogoora burr has been well known as an alternative host. However, the role this weed played in the distribution of the new pathotypes recently recorded in Australia remained unknown.

Karen isolated *V. dahliae* from Ethiopian cabbage, mustard, safflower and Noogoora burr and confirmed these as hosts for the defoliating VCG 1A strain that were particularly virulent on cotton. More recently Karen and her team published the first report of VCG6 isolated from Noogoora burr.

Bioinformatician John Webster has answered questions around why apparently non-defoliating strains of Verticillium werecausing defoliation in cotton.

"The most successful method to manage Verticillium wilt is to manage soil health."

Karen's work sought to understand what role alternate hosts play in the survival and transmission of inoculum. She found that the non-virulent cotton fungal isolate was actually very virulent on Noogoora burr, which means the inoculum produced from a non-virulent strain in cotton can reproduce in weeds and alternate crops with the potential to produce a lot of inoculum. Weeds such as Noogoora can produce up to 115,000 propagules per plant.

Like most soil-borne pathogens, there is no silver bullet control option for *V. dahliae*. Its wide host range, resilient long-lasting spores (known as microsclerotia), and ability to colonise plants' vascular tissue effectively 'hides' it from fungicides, meaning that once present in a field, it is near impossible to eradicate.

Research trials and grower experience has shown corn rotations can reduce the level of disease seen in the following cotton crop, as it allows other fungi in the soil, in particular the non-pathogenic *Fusarium equiseti*, and others to catch up and compete with *V. dahliae*. A fallow field on the other hand is detrimental to all fungi due to a reduction in the amount of carbon present, causing all microflora to suffer.

Reduced levels of all fungi present in the soil under a cotton crop will immediately benefit *V. dahliae*, enabling it to rapidly reproduce and leave its competitors behind, very quickly enhancing the Verticillium wilt problem.

The most successful method to manage Verticillium wilt is to manage soil health. A fertile soil promoting the growth of all soil microorganisms will outperform a barren soil (following fallow) or worse, a soil promoting the growth of only one fungi which is common in back-to-back cotton systems.

The CRDC and CottonInfo Cotton Pest Management Guide contains the most comprehensive up-to-date information on managing Verticillium.

For more

Dr John Webster
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Cotton Pest Management Guide
www.cottoninfo.com.au/publications/cotton-pest-management-guide

Regrow Ag CEO and co-founder Anastasia Volkova.

Powering the success of Australian cotton through world-leading RD&E

CRDC has been driving innovation in the Australian cotton industry for 30 years. From investing in the development of the first genetically modified (GM) cotton varieties in the early 1990s to supporting the creation of a protectant for protect plants against pests in the early 2020s, CRDC continues to invest in world-leading RD&E to benefit our dynamic cotton industry.

Our industry has built a culture of innovation, driven by the commitment to RD&E and its uptake by our highly adaptive growers. Our role is to ensure this culture endures by delivering tangible innovation impacts – helping to increase the productivity and profitability of Australian cotton farms, improve our sustainability and value chain competitiveness, build our adaptive capacity, strengthen our partnerships and the adoption of our research outcomes, and ultimately drive RD&E impact.

Executive Director of the International Cotton Advisory Committee (ICAC) Kai Hughes recently said that from a cotton point of view, Australia is one of the few countries in the world that are at the cutting edge of research.

There have been some major developments in Australian cotton RD&E during 2021–22.

Creating protectants for plants against pests – both disease and insect – is a game-changer for agriculture. BioClay™, a safe and sustainable alternative to chemical pesticide, has had a breakthrough this year against silverleaf whitefly, one of cotton's (and the world's) most damaging agricultural pests. The BioClay technology has been developed over the past decade by the University of Queensland (UQ) with support from CRDC, Hort Innovation and Nufarm Ltd, and is now the focus of the CRDC-supported Australian Research Council (ARC) Hub for Sustainable Crop Protection.

CRDC is also part of a ground-breaking project to address spray drift. A major collaboration with the Grains Research and Development Corporation (GRDC) and Australian agtech company Goanna Ag was announced in March, with the first of a network of towers installed in April to provide real-time weather data and alerts about the presence of hazardous temperature inversions, which is one of the leading causes of spray drift. This project represents the biggest single investment in CRDC's history and the most significant move to improve spray application via RD&E.

These are just two of 213 projects that CRDC has invested in during 2021–22, all designed to deliver impact to growers and the wider cotton industry.

Critically, collaboration remains at the heart of everything we do. There isn't a single research project we invest in that isn't delivered in partnership with our growers, collaborators and cotton researchers. Cotton researchers like CEO and co-founder of Regrow Ag, Anastasia Volkova, named as #1 in *The Australian* newspaper's inaugural edition of *The List: 100 Innovators*. We also partner with those outside our sector to solve issues that are bigger than cotton alone. In 2021–22, 42 per cent of CRDC's investments were

Cotton grower and CRDC Director Ross Burnett with Minister for Agriculture, Fisheries and Forestry, Senator the Hon. Murray Watt.

ASH DWAN

in cross-sectoral RD&E.

In this special *Spotlight* feature, we take a look at some of the highlights of the 2021-22 year.

You can find more detail in our *2021-22 Annual Report* and *Performance Report*, both of are available via the publications section of our website: www.crdc.com.au/publications/crdc-annual-report. You can also find a full list of our current research projects online at www.crdc.com.au/research-development.

YEAR IN REVIEW

CRDC RD&E achievements 2021-22

Major partnership to deliver spray hazard warning system

CRDC and GRDC have collaborated on a $5.5 million investment to help minimise spray drift through a five-year partnership with Australian agtech company, Goanna Ag. Under the partnership, Goanna Ag will develop a spray drift hazardous weather warning system that will provide real-time weather data and alerts to growers and spray operators about the presence of hazardous temperature inversions. The warning system builds on breakthrough research supported by GRDC and CRDC. A study found that the warning system can increase chemical efficacy, improve labour and machinery productivity, and reduce the risk of spraying under hazardous drift conditions, helping the cotton industry avoid $40 million in losses and costs associated with spray drift over five years. The CRDC-GRDC-Goanna Ag partnership is the single largest investment in CRDC's history.

Game-changing spray to revolutionise world-wide pest control

An environmentally friendly spray that targets and kills one of cotton's (and the world's) most damaging agricultural pests – silverleaf whitefly (SLW) – has been created by scientists at the University of Queensland (UQ). The breakthrough is part of UQ's BioClay™ technology, a safe and sustainable alternative to chemical pesticides that has been developed over the past decade by UQ with support from CRDC, Hort Innovation and Nufarm Ltd. The technology is considered a game-changer for crop protection due to its effectiveness against SLW, a small insect responsible for the loss of billions of dollars in agricultural crops around the world.

University of Queensland Professor Neena Mitter leads the BioClay™ research.

Progress towards commercialisation: R&D on path towards commercial release

In 2021–22, several CRDC-supported R&D innovations continued their progress towards commercial release: Pest Detect, the artificial intelligence smartphone app to help identify silverleaf whitefly; BioClay™, the non-toxic, clay-based biodegradable product for crop pests and pathogens; AquaTill Jeticide, the ultra-high pressure water-cutting technology for crop termination; VARIwise, the software that combines in-season imagery with crop production models to provide yield predictions throughout the season; and the CRDC-GRDC-Goanna Ag spray drift hazardous weather warning system. In addition, CRDC also sought a commercial partner for the native plant compound, code named N68, that has potential to become a biological insecticide.

Report on cotton's annual sustainability progress released

CRDC and Cotton Australia released the inaugural annual progress update against cotton's

key sustainability indicators, outlined in the PLANET. PEOPLE. PADDOCK. Sustainability Framework, in June 2022. The annual update, which looks at the year ending June 2021, provides a snapshot of cotton's performance against the nine indicators – PLANET: water, greenhouse gases, biodiversity, pesticides and soil health; PEOPLE: wellbeing and workplace; and PADDOCK: productivity and profitability. The Sustainability Update 2021 shows that improvements have been made in water-use efficiency, greenhouse gas emissions, insecticide hazard, cotton yields and the physical health of people in cotton communities.

Country Road and cotton: helping to protect biodiversity

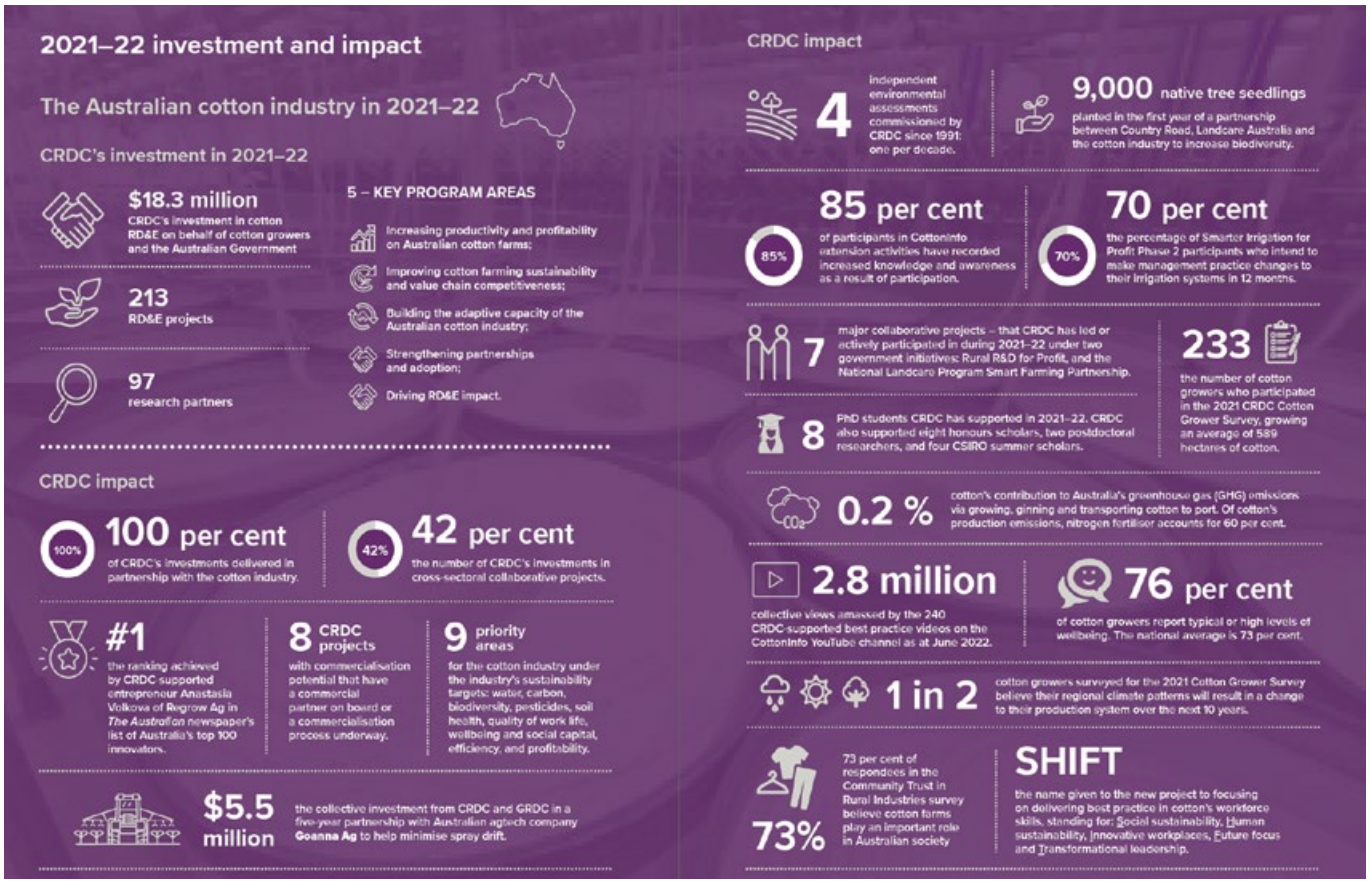
The first year of a partnership between Country Road, Landcare Australia and the cotton industry to improve biodiversity on cotton farms has delivered improvements on 34 hectares in the Namoi Valley of NSW via the planting of 9,000 native tree seedlings. Country Road have committed a minimum $600,000 to the partnership over three years, with funds going to Landcare Australia to support biodiversity restoration projects. The first two projects have involved weeks of restoration work including planting thousands of native trees and grasses on the Namoi River. The partnership draws on a CRDC report that mapped biodiversity in Australian cotton landscapes, identified threatened and endangered species, and recommended ways to protect them.

R&D partnership generating investment funds for dryland cotton research

CRDC and the University of Sydney have partnered on an innovative new initiative to generate additional investment specifically for dryland cotton RD&E. In 2020–21, CRDC contributed to growing 65 hectares of dryland cotton at two of the university's research farms in north-west NSW. The crops were used to support dryland cotton research and when harvested, the initial investment and surplus funds were returned to CRDC for reinvestment with the university for further research. The returns from the crop grown at Narrabri are being reinvested to support a PhD project investigating the radiation-use efficiency of cotton and how it may be improved to increase yield in dryland cotton varieties. The returns from the Spring Ridge crop are supporting a PhD investigating the carbon accounts for dryland cotton production.

Collaboration to tackle major cross-sectoral challenges

Of CRDC's 2021–22 investments, 100 per cent have been in partnership with the cotton industry,



"ICAC's Kai Hughes recently said that from a cotton point of view, Australia is one of the few countries in the world that are at the cutting edge of research."

and 42 per cent in cross-commodity collaborative projects with fellow RDCs. CRDC led three major collaborations during the year: Smarter Irrigation for Profit Phase 2 and More Profit from Nitrogen, under the Australian Government's Rural R&D for Profit program; and Cotton Landcare Tech Innovations 2021, under the National Landcare Program Smart Farming Partnership. CRDC has also partnered in four other projects under the Rural R&D for Profit program, addressing cross-sectoral issues in weeds, biosecurity, energy and diseases. CRDC is also partner in two major RDC initiatives: growAG and Agricultural Innovation Australia (AIA).

RD&E supporting continued northern industry expansion

The Australian cotton industry continues to grow in Northern Australia, with 24,000 hectares of cotton grown in the north in 2021–22, compared to less than 1,000 hectares in 2016–17. A key focus for CRDC is to ensure this development is done sustainably, with best management practices and biosecurity as core priorities. CRDC continues to support the $2.1 million research program for Northern Australia, announced in March 2020, in partnership with the Cooperative Research Centre for Northern Australia (CRCNA) and GRDC. The CRCNA partnership has been further strengthened with CRDC Senior R&D Manager Susan Maas commencing a six-month part-time secondment to help deliver cotton-focused research projects. CRDC is also investing in cotton leadership in the northern cotton industry via 2017 cotton researchers of the years Steve Yeates and Paul Grundy, and a new postgraduate study program for CottonInfo technical lead Sharna Holman.

Start-up focus a success: CRDC-supported innovator ranked #1

CRDC-supported entrepreneur Anastasia Volkova and her company Regrow Ag (formerly FluroSat) have been ranked as number one in a list of innovators published by *The Australian* newspaper: *The List: 100 Innovators*. CRDC has been partnering with Anastasia and her start-up since 2017, when it supported her through a series of start-up workshops that enabled her to

incubate and grow the project. Since then, she's gone on to secure millions in investment, including an equity stake from CRDC, to further develop the state-of-the-art remote sensing and crop/soil modelling technology that allows farmers to measure crop health 'from the air'. Today, Regrow Ag – of which Anastasia is CEO and co-founder – is an award-winning global company that's commercialising climate action through regenerative agriculture.

Minister for Agriculture, Fisheries and Forestry visits CRDC Director on-farm

The Minister for Agriculture, Fisheries and Forestry, Senator the Hon. Murray Watt, visited CRDC Director and cotton grower Ross Burnett on his farm at Emerald just days after being sworn in as Minister. The cotton farm was the first farm visited by the Minister since he was appointed to the portfolio in June 2022, and provided an opportunity for discussion about Australia's cotton industry and CRDC's RD&E investments. In addition to this visit, CRDC Directors also visited a number of cotton farms across the cotton-growing valleys in 2021–22: from Far North Qld, the NT and WA to the southern valleys of NSW. Directors spoke directly to cotton growers in each of the regions about their challenges, opportunities and research needs, and heard from researchers about investments delivering innovations and impacts.

CRDC
COTTON RESEARCH AND DEVELOPMENT CORPORATION

Spotlight is brought to you by CRDC: the Australian cotton industry's research, development and extension investment body, jointly funded by Australian cotton growers and the Australian Government.

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